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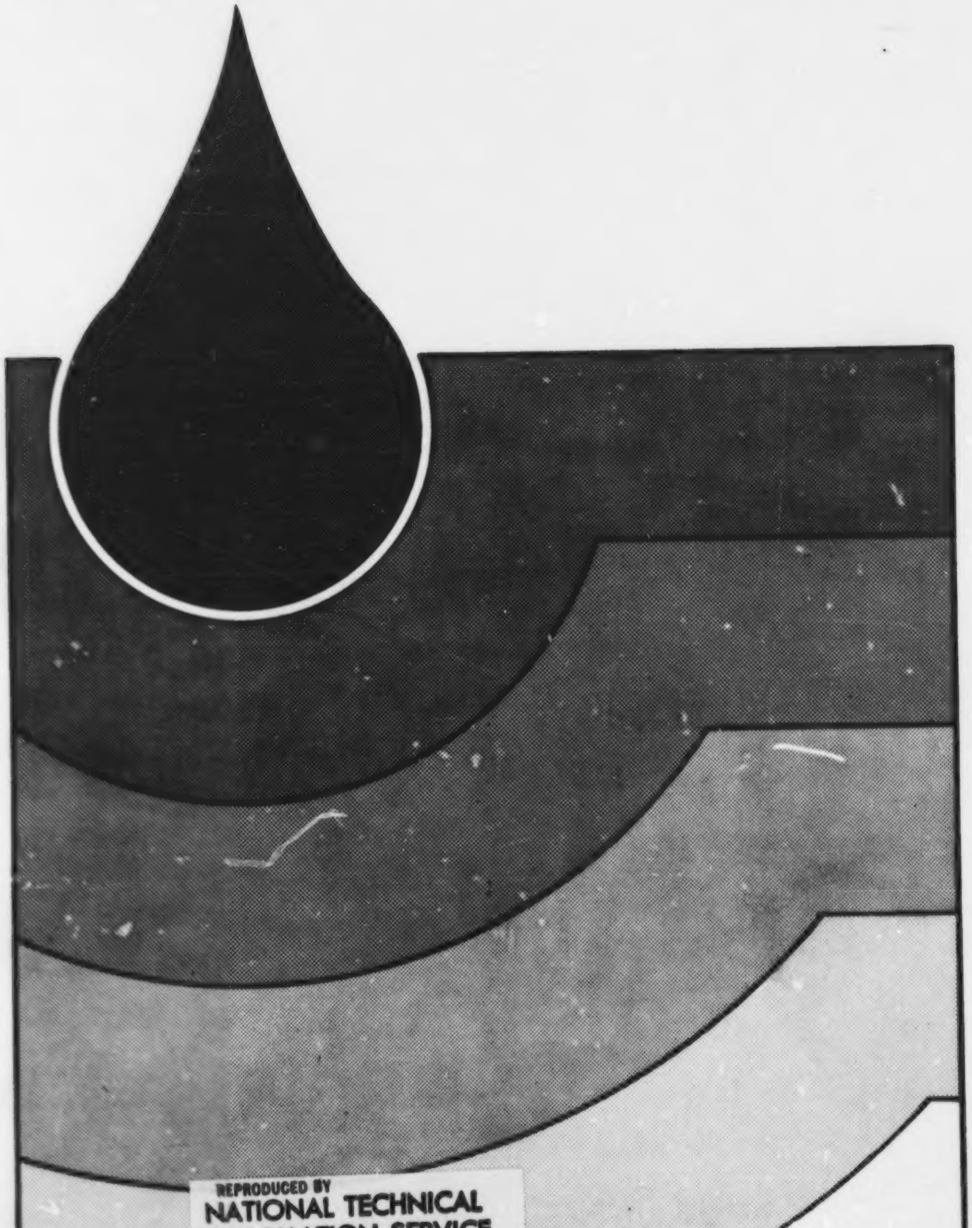

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The purpose of this document is to identify the requirements for R&D support of Program Office activities and to present how ORD is responding or intends to respond to the identified requirements. Both short-term requirements and research responses and long-range research planning are presented. These plans are based on current perceptions of research necessary to address anticipated problems or technology needs. This document resulted from the efforts of the Municipal Wastewater Research Committee. It represents a consensus view of the research and development relating to municipal wastewater needs over the next five years.

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MUNICIPAL WASTEWATER RESEARCH STRATEGY

SUPPLEMENT
1981 - 1985

July, 1981

MUNICIPAL WASTEWATER RESEARCH COMMITTEE

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MUNICIPAL WASTEWATER RESEARCH STRATEGY SUPPLEMENT

TABLE OF CONTENTS

Chapter | Page

1 INTRODUCTION 1-1

2 RESEARCH STRATEGY: 1981-1985 2-1

2.1 Background 2-1
2.2 Legislative and Judicial Requirements 2-2
2.3 Agency Direction and Priorities 2-3
2.4 Overview of the Research Strategy 2-4
2.4.1 Process Development 2-4
2.4.2 Toxic Pollutants Control 2-5
2.4.3 Municipal Sludge Management 2-6
2.4.4 Plant Operations and Design 2-6
2.4.5 Wastewater Land Applications and Aquaculture 2-7
2.4.6 Urban Runoff 2-7
2.4.7 Small Wastewater Flows 2-8
2.4.8 Innovative and Alternative Technology 2-8
2.4.9 Health Effects 2-9
2.4.10 Exploratory Research 2-9
2.5 Research Committee Interfaces 2-10
2.5.1 Water Quality Research Committee 2-10
2.5.2 Drinking Water 2-11
2.5.3 Industrial Wastewater 2-12
2.5.4 Toxic Testing and Assessment 2-12
2.6 Resource Requirements 2-13

3 AGENCY RESEARCH REQUIREMENTS 3-1

3.1 General Requirements 3-1
3.2 Office of Water Program Operations Research Requirements 3-4
3.2.1 Wastewater Treatment and Sludge Management 3-4
3.2.2 Other Wastewater Treatment and Sludge Management 3-7
3.2.3 Land Treatment and Other Natural Treatment Systems 3-7
3.2.4 Innovative and Alternative Technology Program Support 3-8
3.2.5 Sludge Management 3-8
3.2.6 Small Wastewater Systems 3-10
3.2.7 National Urban Runoff Program 3-11
3.3 Office of Water Regulations and Standards Research Requirements 3-15
3.3.1 Process Development 3-15
3.3.2 Toxic Pollutants Control 3-15
3.3.3 Municipal Sludge Management 3-16
3.3.4 Plant Operations and Design 3-17
3.3.5 Land Application of Wastewater and Aquaculture 3-17
3.3.6 Urban Runoff 3-17
3.3.7 Innovative and Alternative Technology 3-18

MUNICIPAL WASTEWATER RESEARCH STRATEGY SUPPLEMENT

TABLE OF CONTENTS

Chapter — Page

3.4 Office of Solid Waste Research Requirements 3-21
3.4.1 Pathogens in Sludge 3-21
3.4.2 Fate and Persistence of PCBs 3-22
3.4.3 Sludge Adherence to Crops 3-23
3.4.4 Fate and Effects of Lead in Sludge 3-23
2.4.5 Land Application to Non-Food-Chain Croplands 3-24
2.4.6 Plant Uptake of Toxic Organics and Heavy Metals 3-24
2.4.7 Epidemiological Studies 3-24
3.4.8 Dietary Cadmium Uptake 3-25
3.4.9 Disposal of Septic Tank Pumpings 3-25
3.5 Office of Pesticides and Toxic Substances Research Requirements 3-28
3.5.1 Toxic Pollutants Control 3-28
3.5.2 Municipal Sludge Management 3-28
3.5.3 Urban Runoff 3-29
3.6 Office of Water Enforcement Research Requirements 3-31
3.7 Regional Offices Research Requirements 3-34
3.7.1 Region I 3-34
3.7.2 Region II 3-36
3.7.3 Region III 3-37
3.7.4 Region IV 3-38
3.7.5 Region V 3-38
3.7.6 Region VI 3-40
3.7.7 Region VII 3-41
3.7.8 Region VIII 3-41
3.7.9 Region IX 3-42
3.7.10 Region X 3-43

4 RESEARCH PLANS 4-1

4.1 Research Plan Overview 4-1
4.2 Process Development Research 4-3
4.2.1 Research Program Description and Objectives 4-3
4.2.2 Recent Research Accomplishments 4-4
4.2.3 Current Research Plan 4-8
4.2.4 ORD Response to Agency Research Requirements 4-8
4.3 Toxic Pollutants Control Research 4-16
4.3.1 Research Program Description and Objectives 4-16
4.3.2 Recent Research Accomplishments 4-17
4.3.3 Current Research Plan 4-19
4.3.4 ORD Response to Agency Research Requirements 4-19

MUNICIPAL WASTEWATER RESEARCH STRATEGY SUPPLEMENT

TABLE OF CONTENTS

Chapter Page

4.4 Municipal Sludge Management Research 4-27
4.4.1 Research Program Description and Objectives 4-27
4.4.2 Recent Research Accomplishments 4-28
4.4.3 Current Research Plan 4-31
4.4.4 ORD Response to Agency Research Requirements 4-32
4.5 Plant Operations and Design Research 4-44
4.5.1 Research Program Description and Objectives 4-44
4.5.2 Recent Research Accomplishments 4-45
4.5.3 Current Research Plan 4-47
4.5.4 ORD Response to Agency Research Requirements 4-49
4.6 Land Application of Wastewater and Aquaculture Research ... 4-63
4.6.1 Research Program Description and Objectives of Land Application of Wastewater 4-63
4.6.2 Recent Research Accomplishments 4-63
4.6.3 Current Research Plan 4-65
4.6.4 ORD Response to Agency Research Requirements 4-66
4.6.5 Research Program Description and Objectives of Aquaculture 4-72
4.6.6 Recent Research Accomplishments 4-73
4.6.7 Current Research Plan 4-74
4.6.8 ORD Response to Agency Research Requirements 4-74
4.7 Urban Runoff Research........ 4-77
4.7.1 Research Program Description and Objectives 4-77
4.7.2 Recent Research Accomplishments 4-78
4.7.3 Current Research Plan 4-80
4.7.4 ORD Response to Agency Research Requirements 4-82
4.8 Energy Research 4-89
4.8.1 Research Program Description and Objectives 4-89
4.8.2 Recent Research Accomplishments 4-90
4.8.3 Current Research Plan 4-91
4.8.4 ORD Response to Agency Research Requirements 4-92
4.9 Small Wastewater Flows Research 4-96
4.9.1 Research Program Description and Objectives 4-96
4.9.2 Recent Research Accomplishments 4-96
4.9.3 Current Research Plan........ 4-97
4.9.4 ORD Response to Agency Research Requirements 4-98
4.10 Innovative and Alternative Technology Research 4-104
4.10.1 Research Program Description and Objectives 4-104
4.10.2 Recent Research Accomplishments........ 4-106
4.10.3 Current Research Plan 4-107
4.10.4 ORD Response to Agency Research Requirements 4-107
4.11 Health Effects Research 4-112
4.11.1 Research Program Description and Objectives 4-112
4.11.2 Recent Research Accomplishments 4-112
4.11.3 Current Research Plan 4-112
4.11.4 ORD Response to Agency Research Requirements 4-113

MUNICIPAL WASTEWATER RESEARCH STRATEGY SUPPLEMENT

TABLE OF CONTENTS

Chapter — Page

4.12 Exploratory Research 4-125
4.12.1 Program Objectives 4-125
4.12.2 Current and Proposed Exploratory Research Projects 4-125
4.13 Technology Transfer 4-127
4.13.1 Objectives 4-127
4.13.2 Small Wastewater Flows 4-127
4.13.3 Innovative and Alternative Technology 4-128

MUNICIPAL WASTEWATER RESEARCH STRATEGY SUPPLEMENT

APPENDICES

Appendix		Page
A	Research or Related Activities of the EPA Operating Programs, Regions and Other Federal Agencies	A-1
B	ORD Technical Information Outputs for the Municipal Wastewater Research Committee	B-1
C	Municipal Wastewater Research Committee and Subcommittee Members	C-1
D	Headquarters and Laboratory Staff Contacts for Municipal Wastewater Research Program Outputs	D-1

MUNICIPAL WASTEWATER RESEARCH STRATEGY SUPPLEMENT

LIST OF TABLES

Table | Page

CHAPTER 2: RESEARCH STRATEGY

2.1 Research Program Resources 2-14
2.2 New Initiatives 2-15

CHAPTER 3: SUMMARY OF RESEARCH NEEDS

3.1 Office of Water Program Operations 3-12
3.2 Office of Water Regulations and Standards 3-19
3.3 Office of Solid Waste 3-26
3.4 Office of Pesticides and Toxic Substances 3-30
3.5 Office of Water Enforcement 3-32
3.6 Regional Offices 3-44

CHAPTER 4: SCHEDULE OF R&D OUTPUTS

4.1 Process Development 4-12
4.2 Toxic Pollutants Control 4-25
4.3a Municipal Sludge Management: Processing and Stabilization 4-38
4.3b Municipal Sludge Management: Conversion and Energy Recovery 4-40
4.3c Municipal Sludge Management: Land Application Management and Disposal 4-42
4.4a Plant Operations and Design 4-54
4.4b Plant Operations and Design: Collective Rankings of Factors Limiting Plant Performance 4-59
4.4c Plant Operations and Design: National Survey, EPA Program and Other Identified Needs Addressed by POD Program 4-61
4.5a Land Application of Wastewater 4-70
4.5b Aquaculture and Wetlands 4-76
4.6 Urban Runoff 4-87
4.7 Energy 4-95
4.8 Small Wastewater Flows 4-103
4.9 Innovative/Alternative Technology 4-110
4.10 Health Effects 4-122

CHAPTER 1: INTRODUCTION

The Municipal Wastewater Research Program is designed to provide the technology and science support to the Environmental Protection Agency offices that implement the regulatory aspects of the applicable legislative acts. The Agency offices with the primary responsibility for implementing various portions of the legislative acts are referred to in this document as the "Program Offices" and are the users or "clients" for ORD outputs. Every attempt has been made to relate ORD activities to the appropriate client office(s).

While many legislative acts have some relationship to municipal wastewater research and development (R&D), the most significant in terms of research authorization and requirements for support from the Office of Research and Development (ORD) are the Federal Water Pollution Control Act (PL 92-500), as amended by the Clean Water Act Amendments of 1977 (PL 95-217) and the Resource Conservation and Recovery Act of 1976 (PL 94-580).

The purpose of this document is to identify the requirements for R&D support of Program Office activities and to present how ORD is responding or intends to respond to the identified requirements. Both short-term requirements and research responses and long-range research planning are presented. These plans are based on current perceptions of research necessary to address anticipated problems or technology needs. This document resulted from the efforts of the Municipal Wastewater Research Committee. It represents a consensus view of the research and development relating to municipal wastewater needs over the next five years.

The establishment of the Municipal Wastewater Research Committee is an outgrowth of a FY 1978 pilot effort involving five research committees. The success of that effort in improving communication and understanding between the Program Offices and ORD led to an expansion of that activity that now involves the following 14 research areas and their respective research committees.

- Water Quality
- Municipal Wastewater
- Drinking Water
- Industrial Wastewater
- Solid Waste
- Toxics Testing and Assessment
- Superfund
- Mobile Source
- Oxidants
- Gaseous, Inhalable particulates
- Hazardous Air Pollutants
- Pesticides
- Energy
- Non-Ionizing Radiation

The Municipal Wastewater Research Committee has working relationships with the Water Quality, Industrial Wastewater, Drinking Water, and Toxics Testing and Assessment Research Committees. Coordination with the Solid Waste, Energy and Air Pollutant Research Committees occurs on an "as needed" basis. The municipal wastewater research strategy for 1981 through 1985 is presented in Chapter 2. The strategy discusses Agency direction, priorities and resource requirements along with the appropriate research committee relationships. Chapter 3 describes the research requirements of the Program Offices and the Regions. These Offices were solicited to identify and prioritize research needs. About 200 requirements, categorized in accordance with the research areas in the R&D program, were listed by the Program and Regional Offices. Chapter 4 is a comprehensive description of the current and planned research program developed in response to the stated needs of the Agency clients. It also presents a listing of recent accomplishments and a listing of reports that can be used to satisfy information requirements.

CHAPTER 2: RESEARCH STRATEGY: 1981-1985

2.1 BACKGROUND

This research strategy has been developed to coordinate research activities by the Environmental Protection Agency (EPA) to carry out its responsibilities in the area of municipal wastewater pollution control. It considers a time period of five years (1981 - 1985) and thus includes both immediate objectives and longer range planning in several evolving areas of research. The Regional Offices and five Headquarters Offices with program implementation responsibilities have identified 219 individual research requirements in 10 areas of municipal wastewater research. Approximately one-third of these individual research requirements are common across several Program Offices, each having a different rationale for such research. The following sections summarize the legislative requirements directing Agency activities, the direction adopted by the Agency and the supporting Office of Research and Development's (ORD) research effort.

2.2 LEGISLATIVE AND JUDICIAL REQUIREMENTS

The Federal Water Pollution Control Act Amendments of 1972 (PL 92 - 500), as amended by the Clean Water Act (CWA) of 1977 (PL 95 - 217), constitutes the primary force behind the Agency's efforts in municipal wastewater pollution control. Basic to the Act is the imposition of technology-based controls on municipal discharges. This provides the fundamental impetus to ORD's efforts in control technology development. The specific requirements of the Act foster a variety of program and research activities on specific areas of concern such as toxic pollutants control, sludge management, land treatment of wastewater and aquaculture, small wastewater flows, urban runoff and the use of innovative and alternative technology.

Additional legislation under the Resource Conservation and Recovery Act (RCRA) defines sludges from wastewater treatment plants as solid waste and identifies, as a health or environmental problem, inadequate and environmentally unsound practices for the disposal or use of solid waste (including sludge and other pollution treatment residues). Further, the Marine Protection, Research and Sanctuaries Act of 1972 (often known as the "Ocean Dumping Act"), as amended in 1977, directs EPA to end the dumping of harmfulsewage sludge into the oceans by December 31, 1981. EPA presently carries out research to develop alternatives to ocean dumping as a sludge disposal option.

2.3 AGENCY DIRECTION AND PRIORITIES

The research program will be guided by the new direction and policies for implementing the nation's future water quality programs. The Agency's new direction will emphasize the following:

- Re-orient Agency construction grants program to support state delegated programs through increased technical support
- Integrate the construction grants, water quality and the permits and enforcement programs to increase the rate of compliance and improve the operation and management of existing facilities
- Aid states in developing improved water quality impact and waste load analysis techniques to make better informed construction grant decisions
- Base construction of treatment plants on an assurance that the beneficial impacts on water quality improvement justify the expenditure of public funds

The priority research areas identified for technology development by the Program Offices and the Regions are:

- High: Implementation of innovative and alternative technology program; sludge management; and improved plant operations including energy conservation
- Medium: On-site treatment systems; advanced novel biological processes; aquaculture systems; land application of wastewater; control of toxic pollutants; and combined sewer overflows
- Low: Best management practices for stormwater runoff; wastewater disinfection; nutrient control; and water conservation and reuse

2.4 OVERVIEW OF THE RESEARCH STRATEGY

The Municipal Wastewater Research program will focus on supporting the Regions and especially the states in carrying out their water pollution control programs. Focus will be on the development of efficient and cost-effective treatment technology to assure that the municipalities will have the tools to carry out their environmental programs economically. Concentration will also be on those technical areas that have the broadest application.

Because of the escalating costs of constructing conventional treatment works, one of the main thrusts of technology development will be in the area of combating the effects of inflation. Resources will be directed toward novel process development with breakthrough potential in the areas of cost reduction (construction cost, energy requirements, manpower), reduced space requirements, reduced sludge production, improved efficiency, dual-use facilities and conservation of natural resources.

Technology and abatement/control program alternatives will be evaluated for their abilities to remove "toxicity" and other characteristics impacting stream quality and beneficial use, and for determining least cost approaches.

The health effects research program will be closely coordinated and will generally follow the above technology development priorities.

The research effort is organized into 10 areas described below. Within each area, an individual plan has been formulated. Each plan attempts to utilize available resources in the best way to address Agency needs.

2.4.1 Process Development

This program area has four elements: novel biological processes, specific pollutant control, microbial control and water reuse/conservation. Anticipated emphasis in the immediate future will be primarily on developing novel biological processes which will support the Agency's innovative and alternative program. This element is directed toward improved cost effectiveness and reliability of municipal wastewater treatment projects, and should have the greatest pay-off on a national basis in the construction and modification of wastewater treatment plants. The specific pollutant control activities in the past have included work on the biodegradation of toxic compounds and nutrient (nitrogen and phosphorus) control. Because of limited resources, future specific pollutant control activities will be confined to the highest Agency priority work which can be accomplished in-house. The microbial control efforts will focus on the completion of the Disinfection Design Manual, which will detail current state-of-the-art on design and operational practices for chlorination/dechlorination, ultraviolet and ozone disinfection. This Design Manual should meet the needs of the Regional Offices and the states for information on disinfection practices. The water reuse/conservation element is being phased out and will consist primarily of monitoring the city of Denver's Potable Reuse project. Other areas where work is planned and is also contingent on the availablity of resources include guidelines for dual distribution system for nonpotable reuse, and a summary report on water conservation practices in the eastern part of the United States.

2.4.2 Toxic Pollutants Control

The objectives of the research plan are to define the sources, pathways and concentrations of priority pollutants as well as to assess and improve the treatability of such compounds. The lack of appropriate or practical monitoring and analytical techniques for toxic compounds is currently the most critical deficiency in the area of municipal wastewater control. The gap impedes the resolution of important health-related issues as well as the application of several alternative approaches to treatment and disposal. Program and Regional Offices have expressed additional needs to define the sources, occurrence and removal of toxic compounds in treatment plants; the development of improved treatment processess or alternatives such as source control; and the evaluation of the effects of toxic compounds released by Publicly Owned Treatment Works (POTWs). Significant planned outputs include detailed source data of toxic compounds in treatment facilities from a 25-city survey; the examination of several treatment processes for removing toxic compounds; and the development of toxic control options/strategies through various modelling and systems analysis approaches.

2.4.3 Municipal Sludge Management

This research focuses on three elements: processing and treatment; conversion and energy recovery; and land application, management and disposal. High priority needs identified for each of these elements include: pathogen control; thermal conversion of sludge; and the effect of toxic organic compounds contained in sludge that is applied to the land. Research on heavy metal effects, especially cadmium, on food-chain crops will be de-emphasized. In cooperation with USDA, focus will be on higher rate land application processes and acceleration of the development of good management practices for applying sludge on farmlands. Processing outputs are planned for technologies involved with dewatering, disinfection, digester energy recovery and toxicants removal. Conversion outputs will include improved processes on incineration, pyrolysis, composting and resource recovery. Land application and disposal outputs are planned for toxicants, the fate and effects of pathogens, and the use of sludge for energy crop cultivation.

2.4.4 Plant Operations and Design

Research in this area is aimed at improving POTW reliability and compliance with effluent regulations as well as reducing costs of construction, operation and maintenance of such facilities. The need for the former goal is particularly emphasized by a 300-plant, 3 1/2 year Agency study which identified over 70 specific problems with non-complying treatment facilities. Other high-priority needs identified by Agency Offices include the need for developing improved design information for unit processes and energy conservation. Significant future research outputs are planned for improving plant operation and design, methods for problem assessment of non-complying POTWs, POTW operation and maintenance costs, and producing a series of unit process design information documents. An important part of this program with high potential pay-off is the application of automation and process control systems. A minimum but viable effort will be maintained in the development of new applications for automation systems and the establishment of quality assurance for measurements made from on-line monitoring and control systems.

2.4.5 Wastewater Land Application and Aquaculture

Research in this area has the objective of developing three types of systems: slow rate (irrigation); rapid infiltration; and overland flow. Another area of natural treatment systems under study is the use of aquaculture for wastewater treatment and resource recovery. To instill confidence in the use of land application, the Agency Offices have given a medium priority to the assessment of the movement of toxics and pathogens in such systems along with the definition of any possible health effects. The refinement of design and operating practices is also a medium priority. Research in this area involves demonstrations of the three major land-treatment techniques with a design manual as a major output goal. The use of water hyacinths, other aquatic species and wetlands for wastewater treatment are undergoing evaluation.

2.4.6 Urban Runoff

Urban Runoff, especially stormwater runoff control, is no longer an Agency research priority. The Agency's Nationwide Urban Runoff Program (NURP) and Clean Lakes program will be phased out in FY 82. Research funds for urban runoff have steadily declined in recent years and only the highest priority Agency needs will be addressed. Major needs include the development of a new procedure for evaluating and correcting infiltration/inflow (I/I) problems and the development of cost-effective techniques for rehabilitating service connection lines. Other priorities in the combined sewer overflow (CSO) area will be addressed over a longer period at greatly reduced funding. These include the assessment of various combined sewer overflow control technologies, culminating in a CSO design manual and a compendium of best management practices for urban runoff control. Priority needs relating to the impacts of CSO and runoff on receiving water and indigenous biota should be addressed jointly with the Water Quality Research Committee.

2.4.7 Small Wastewater Flows

This program area is oriented to be responsive to the needs of the Agency and the states with state-of-the-art design and operating information. Planned activities include: the Small Wastewater Flows Clearinghouse for the dissemination and exchange of information located at West Virginia University; the Cincinnati Center for the controlled study of viable alternative technologies; initiation of a contract to develop the handbook for alternative wastewater collection systems; and continuation of a level-of-effort contract designed to respond to the needs of the Regional Offices and the states for assistance primarily in the areas of alternative on-site technology and small collection systems. With these activities, it is anticipated that technical assistance by the Small Wastewater Flows (SWF) staff will remain at the present level even as demand for more assistance occurs. The Clearinghouse should be particularly helpful in reducing the need for technical assistance directly from the lab as new materials are developed and new personnel at the Clearinghouse are trained in the small wastewater flows program.

2.4.8 Innovative and Alternative Technology

Innovative and alternative technology (I/A) is one of the highest priority areas for municipal wastewater research. Research is divided into four elements: technical support which provides review of I/A facility designs; information dissemination; the active I/A program, which identifies and promotes emerging technologies; and the I/A research program. Highest priority should go to an expansion of the active I/A program and post-construction evaluations of I/A projects. Additional resources and travel funds are needed, however. Demonstrations of new technologies and the Clearinghouse functions must continue. Planned major outputs include the support of several new I/A research projects and emerging technology assessments. Initiation of a post-construction evaluation program and continuance of the I/A program in FY82 will depend upon provisions in the upcoming amendments to the Clean Water Act.

2.4.9 Health Effects

Health effects research pervades most aspects of municipal wastewater control, but the current plan focuses on determining the impact on human health and the development of criteria in three areas: wastewater and sludge management; wastewater reuse; and urban runoff. The top priority needs in this area, identified by the Program and Regional Offices, are to provide health assessments in these three areas. Major outputs relating to pathogens and toxic compounds are planned for each area.

2.4.10 Exploratory Research

To achieve a reasonable balance between the immediate needs of the Agency and the general advancement of science through longer term activities, 15 percent of the resources in the extramural research program have been and will continue to be set aside for long-term exploratory research. The objective of the grant program is to supplement ORD activities by stimulating scientific and technical research fundamental to pollution control advances. Specific program guidance will be given by the Research Committee for solicitation for grant proposals on an annual basis.

Another supplement to the ORD program is the recent establishment of a number of innovative research centers at competitively selected universities. One of these centers, relative to municipal wastewater, is the Advanced Control Technology Research Center at the University of Illinois at Urbana. This program should provide a better link between basic and applied research as related to the Municipal Wastewater Research Program.

2.5 RESEARCH COMMITTEE INTERFACES

The legislative mandates and the efforts to develop cohesive Agency policy in the water resources area create the need for interactive research planning across several research committees. In order to insure that the research effort is both responsive and efficient, water pollution issues involving inter-committee consideration must be identified and the responsibility for their resolution must be allocated. In various places in this document, research efforts requiring the cognizance of other committees are identified to facilitate the planning of efficient research. The discussion below identifies those research areas which require joint committee review and coordination as determined by the Municipal Wastewater Research Committee.

2.5.1 Water Quality Research Committee

Water quality impacts of point sources. The Municipal Wastewater and the Water Quality Research Committees have agreed to their respective roles in planning and implementing research on the ecological efects, including water quality impacts, of point source discharges into natural water systems.

The Water Quality Research Committee is to address the informational needs of the selected Program Offices (Office of Water Regulations and Standards; Water Planning Division of the Office of Water Program Operations; Office of Water Enforcement; and the Office of Federal Activities) concerning impacts on water quality. This will be accomplished through the established ranking process of the Committee and the Agency within the given budget constraints for FY83. When joint participation is desirable, research will be planned by the Water Quality and Municipal Wastewater Research Committees for ecological effects and control technology, respectively. Mutual research needs expressed by the Program Offices include:

- Water quality criteria development and validation
- Fate and effects of toxic pollutants in aquatic systems from point source discharges
- Evaluation of urban runoff impacts (including combined sewer overflow) on sediment and water quality and aquatic biota

- Retrospective assessment of ambient water quality improvements from both point and non-point source water pollution control projects versus predicted improvements, as necessary to evaluate the effectiveness of predictive techniques used
- Investigations concerning the impacts of human activities on natural wetlands

Urban runoff (non-point source and watershed management). Research in the area of effects and control of pollution from urban runoff is to be coordinated by the Municipal Wastewater Research Committee and the Water Quality Research Committee. The Water Quality Research Committee will have the responsibility for planning the research required to establish the impacts of urban stormwater and combined sewer overflows on receiving waters and the indigenous biota. This research will provide the technical backup for establishing wet-weather water quality criteria and will be utilized to assist in determining remedial facility performance requirements for design purposes. The Municipal Wastewater Research Committee will be responsible for planning control technology development and the development of the supporting health effects data base for both urban stormwater and combined sewer overflows. Further development and/or improvement of mathematical models in the urban runoff impact/prediction area will be the primary responsibility of the Water Quality Research Committee.

Wetlands for wastewater management. The Municipal Wastewater Quality Research Committees have agreed that all research relating to the use of wetlands for wastewater treatment, including control technology and ecological effects, will be planned by the Municipal Wastewater Research Committee. Implementation of the control technology research is planned by the Office of Environmental Engineering and Technology and ecological effects by the Office of Environmental Processes and Effects Research. Control technology addresses the abatement needs for both urban point and non-point source generated wastewater.

2.5.2 Drinking Water Research Committee

Both the Drinking Water Research Committee and the Municipal Wastewater Research Committee have similar and direct interests in the research related to production and feasibility of using renovated municipal wastewater for potable purposes. Both committees coordinate closely with the Office of Drinking Water which also has an interest in non-potable reuse. The committee interface is primarily one of information exchange and, when needed, advice from the other Committee.

2.5.3 Industrial Wastewater Research Committee

Because of the requirement for industrial pretreatment prior to discharge of effluent to a POTW, a strong interactive arrangement is required between this Committee and the Industrial Wastewater Research Committee. The primary focus of the cooperative effort is to be on determining the proper balance of industrial pretreatment of toxics versus pass-through of toxics for treatment at POTWs. Active discussions are on-going between the two committees.

2.5.4 Toxics Testing and Assessment Research Committee

In order to focus on the proper analytical procedures and methods of testing for toxic pollutants, discussion has been initiated between the Municipal Wastewater Research Committee and the Toxics Testing and Assessment Research Committee. Major points will be quality assurance and control methods for technology performance evaluations. In addition, the results of the sludge-related research on toxic contaminants carried out by the Municipal Wastewater Research Committee of interest to the Toxics Research Committee will be made available as they are developed.

2.6 RESOURCE REQUIREMENTS

Based on the demands of the Agency for research in this area, the annual resources that are anticipated for municipal wastewater research in the upcoming years will probably be inadequate. The current FY81 budget of $18.4 million has been decreased by $1.7 million in the FY82 budget request. At present, the current research budget continues to represent only a small fraction (0.7%) of the municipal facilities construction grants program ($2.4 billion) and other agency programs which it is designed to support. Table 2.1 shows the current operating budget for FY 82 and the changes in resources from FY81.

Significant new research requirements which have important budgetary implications for ORD have been identified. The reprogramming of existing and already limited funds to address this additional work is not advisable. The Committee recommends, therefore, that these research requirements be addressed by adopting specific new initiatives described in Table 2.2 and elsewhere in this document.

TABLE 2.1

MUNICIPAL WASTEWATER RESEARCH PROGRAM RESOURCES

	Current FY 81			FY 82 Request			
Technical Areas	Total($K)	IH($K)	Extra($K)	Total($K)	IH($K)	Pos.	Extra($K)
Sludge Management	3,558.3	855.3	2,703.0	3,439.5	1,261.5	24.0	2,178.0
I/A Technology	828.0	317.0	511.0	971.0	400.0	8.0	571.0
Toxic Pollutants Control	1,307.0	654.0	653.0	973.0	640.0	12.8	333.0
Small Flows	750.0	215.0	535.0	600.0	250.0	5.0	350.0
New Process Development	2,456.4	1,045.1	1,411.3	2,341.3	1,050.0	21.0	1,291.3
Plant Operations & Design	1,459.0	402.0	1,057.0	1,058.1	400.0	8.0	658.1
Urban Runoff	1,255.0	330.0	895.0	660.0	250.0	5.0	410.0
MERL-Cinn Subtotal	11,583.7	3,818.4	7,765.3	10,042.9	4,251.5	81.8	5,791.4
Ada Lab (Land Application)	1,292.0	763.0	529.0	1,033.0	730.0	17.0	303.0
Headquarters	1,536.8	230.0	1,306.8*	1,988.9	364.2	5.6	1,624.7*
Subtotal	14,412.5	4,811.4	9,601.1	13,064.8	5,345.7	109.4	7,719.1
Health Effects	3,393.8	1,160.6	2,233.2	3,037.8	859.6	17.3	2,178.2
Technical Information	608.0	360.0	248.0	625.0	377.0	5.0	248.0
GRAND TOTAL	18,414.3	6,332.0	12,082.3	16,727.6	6,582.3	131.7	10,145.3

*Includes 15% setaside for Exploratory Research Program

Table 2.2

NEW INITIATIVES FOR MUNICIPAL WASTEWATER RESEARCH

NEW INITIATIVE	Required Funds ($ million)	Duration (years)	New Positions
1. Post construction evaluations of I/A projects	2, 4, 8	3	6
2. Natural treatment systems - Wetlands, Land Application, Aquaculture	1	*	3
3. Sludge management			
a. Thermal conversion technology demonstrations	0.8	3	0
b. Accelerate land reclamation with USDA participation	0.2	3	0
4. Health aspects of Small Wastewater Flow Systems, Aquaculture, Urban Runoff	0.6	*	0
5. Evaluation of Small Flows 201 Projects	1.0	*	1
6. Improve O&M for small community wastewater systems	0.5	2	1
7. Wastewater Process Development			
a. Accelerate development of cost-reducing energy-saving novel biological processes	1.5	*	1
b. Increase research in small flow research center	0.5	*	0

*Recommended ongoing effort, funds are required on a per year basis

CHAPTER 3: AGENCY RESEARCH REQUIREMENTS

3.1 GENERAL REQUIREMENTS

This chapter describes the research requirements identified by the groups concerned with muncipal wastewater control technology within the headquarters and Regional Offices. The six users of ORD research in municipal wastewater technology are:

- Office of Water Program Operations (OWPO)
- Office of Water Regulations and Standards (OWRS)
- Office of Solid Waste (OSW)
- Office of Pesticides and Toxic Substances (OPTS)
- Office of Water Enforcement (OWE)
- Regional Offices

The priorities for the research needs of the Program and Regional Offices are identified in Tables 3.1 to 3.6.

There are research needs common to more than one Program Office. Although each office may require the research output for different reasons, it is useful to be aware of these overlapping needs since they represent areas where research programs would most effectively address Agency needs. These common needs are concerned mainly with toxic compounds, pathogens and sludge. A description of these items follows.

Most of the Program Offices and Regions I, II, VI, and VIII are concerned with the development of environmentally acceptable land spreading methods for the use and disposal of sludges. The fate and effects of toxic compounds and pathogens on land used for sludge disposal is of interest to OWPO, OWRS, OSW and the Regions. Both agricultural and non-agricultural lands (forestry, energy farms etc.) and lands in need of extensive reclamation are of interest. OWPO, OWE, OSW and the Regions have a major interest in the transport of toxics up through the food-chain to the point where products are used for human consumption. OWRS is also interested in this from the viewpoint of using any criteria developed on toxics in sludge used for beneficial purposes.

The need for improved analytical techniques for toxics and pathogens has been emphasized by OWRS, OWE, OWPO and OSW. Because of the large number of toxic compounds and organisms, the often small concentrations in which they occur, and the sophisticated instrumentation required for their measurement, the monitoring of toxics and pathogens often results in a very expensive and somewhat incomplete effort. Moreover, the techniques used in the assessment of the fate and impact of these contaminents in the environment are often inadequate. Hence the development of less expensive analytical and compliance monitoring procedures, is needed. Along with this, the development of indicator parameters and surrogate techniques which would parallel the presence and dangers of these materials, is also needed. Monitoring data for material balances of toxic compounds in POTWs are needed by OWPO, OWRS, and OPTS. More emphasis on toxic compound removal would assist OWPO and OWRS by providing state-of-the-art information removal capabilities for toxic compounds. Moreover, the continuous discharge of toxic compounds from POTWs necessitates the evaluation of the effects and impacts of these materials on the environment, and both OWRS and OWE have indicated the need for a valid methodology to do this. Detailed information on the fate and effects of these materials from land-applied wastewater is also needed by OWPO and OWRS.

The construction grants program has identified the improvement of POTW reliability and compliance with effluent requirements as a major problem area. Other high priority needs include the development of a design information series of documents for new and improved treatment processes, information on energy conservation and increasing technical assistance for correcting operational problems.

Small wastewater flows have been cited as a major problem by a number of the Regions. Research needs which Regions I, V, VII and IX share with OWPO include the improvement of cost, design, performance and reliability information for on-site systems. Urban runoff controls relate to the interests of OWPO, OWRS, and the Regional Offices. All three groups need the development of methods to produce information relating to the impact of urban runoff (both with and without control technology) upon receiving water quality and biological integrity. Both OWRS and Region V have expressed an interest in urban runoff data for wet-weather flow criteria. In addition, OWPO and Regions I and X are jointly interested in methods for dealing with infiltration/inflow problems and in ways to optimize the size and efficiency of combined sewer overflow (CSO) facilities.

A need for detailed evaluations of selected innovative and alternative (I/A) systems has been expressed by both OWPO and Region V. In addition, OWPO and Regions III, V, VII and VIII await the finalization and publication of a disinfection design manual.

Finally, several offices (OWPO, OWE, and OPTS) expressed an interest in maintaining an up-to-date intelligence on ORD activities and output content. The development of a matrix of research projects and the responsible individuals within ORD would expedite the acquisition of research updates. Several efforts presently under way by ORD to address this need for information will be discussed in Chapter 4.

3.2 OFFICE OF WATER PROGRAM OPERATIONS RESEARCH REQUIREMENTS

The Office of Water Program Operations is concerned primarily with water pollution control facilities associated with municipalities. Facility planning, design requirements, municipal construction, runoff-related pollution, spills, and emergency responses fall under the jurisdiction of this Office. The chief branch of OWPO dealing with technology for municipal wastewater treatment is the Municipal Technology Branch of the Municipal Construction Division. This branch is concerned with directing technically-related construction grant activities at the national level. The main goal is to promote the planning, design and construction of municipal wastewater treatment plants in a manner which is cost-effective and technologically and environmentally sound.

An additional point of contact between the Municipal Wastewater Reasearch Committee and OWPO is the National Urban Runoff Program (NURP) under the Water Planning Division. Ultimately, the program's aim is to fill information deficiencies regarding pollutant sources, areal accumulation patterns, washoff and transport mechanisms, instream behavior of pollutants, and the effectiveness of control measures. In addition, the practical implications of the resulting impacts on water quality and aquatic ecosystems are to be addressed. Projects currently underway involve sampling for the presence of various pollutants in receiving waters ranging from small streams to oceans. The sampling programs will be augmented in some cases by an evaluation of best management practices (BMPs) for the control of pollutants in runoff.

Both NURP and the Municipal Technology Branch require support over the next five years from ORD. The research needs outlined by these offices are presented below and summarized in Table 3.1.

3.2.1 Wastewater Treatment and Sludge Management

Toxic compounds. There is a need to develop in-plant treatment processes for toxic compound removal. Rather than focusing on high technology processes, research should be directed toward adequately satisfying practical constraints such as cost effectiveness, energy requirements and the fate of the removed compounds. Current work needs to be published on the binding of toxic compounds to the sludge and on their extraction from the sludge. This should include the feasibility of metal recovery for reuse. There is also a need to identify the flow of toxic compounds through all the process streams in a treatment plant. For example, what is the optimum distribution of these compounds in conventional or newly-designed process streams that would facilitate their most satisfactory final disposition? Hence, a comparative assessment is needed of the capabilities of the various wastewater treatment and sludge management technologies for removing or destroying toxic compounds. This will allow for rational decisions in managing the fate of toxic compounds by identifying their levels in the plant's influent, aerosols, sludge and effluents. Such information is needed so that it can be incorporated into design and operation and maintenance (O&M) guidance documents.

Energy. The two main areas of concern are conservation in energy-intensive treatment processes and energy recovery. Research on energy consumption and conservation possibilities is needed for such processes as aeration, pumping, thermal drying, reduction of sludge volumes and sludge conveyance. Nonprocess components such as chemicals (lime and disinfectants) and heat pumps also contain inherent energy demands which need to be characterized. Energy-producing sludge management processes (e.g., co-disposal, digestion, autothermal processes, refuse-derived fuels) need to be compared to alternative sludge disposal procedures in terms of cost, performance, reliability and environmental considerations. The use of natural systems as an energy effective treatment process and the production of biomass for energy by recycling wastewaters and sludges should be investigated. It must be determined whether energy recovery technologies are feasible and cost-effective for municipal treatment plants. Results of the energy-related research should be incorporated into an energy manual for municipal treatment plants. The manual should identify the balance between conservation in conventional systems and the use of inherently low energy processes that still can achieve satisfactory levels of wastewater treatment. At a minimum, energy conservation and recovery should be considered in facility design and O&M guidance documents.

Disinfection. This technology has probably matured to the point that, barring any major breakthroughs, research activity can be decreased to a minimal level. Information on currently available conventional chlorination and alternative disinfectants should be published. A disinfection design manual should be produced, concentrating on cost and energy requirements as well as improved effectiveness for conventional treatment of effluents.

Non-point sources. Included in this category are urban runoff, infiltration/inflow, and combined sewer overflows. Research needs for the National Urban Runoff Program (NURP) are given at the end of this section. In deference to more pressing research needs, ongoing work on somewhat matured control technologies such as swirl and dissolved air flotation devices should be minimized and the results consolidated, evaluated and published as a design manual on these combined sewer and wastewater overflow controls. Moreover, work in support of using the stormwater management model (SWMM) should be minimized. Of higher priority is the need to evaluate the impact of combined sewer overflow controls on water quality and benthic communities. Also, there is a need to evaluate the impact of urban runoff and combined sewer overflows on water quality, public health, recreation and shellfish resources. Data from the NURP should be used in such studies. Similarly, urban runoff controls such as street sweeping, detention and the use of wetlands need to be assessed using NURP data. Research on infiltration/inflow (I/I) is needed to develop a standardized methodology for I/I problem evaluation along with improved methods for sewer rehabilitation and maintenance.

Design information and guidelines. Existing design documents should be updated to include advancements in wastewater treatment and sludge management technologies and practices. Research and design information on newer processes such as deep shaft and U-tube treatment should be developed. It may be beneficial to include peer review of design guidelines by professional societies or to stimulate these groups to develop updated design documents.

3.2.2 Other Wastewater Treatment and Sludge Management

Most design manuals assume average values for plant influent characteristics. A methodology is needed to better evaluate and design for variabilities in flow and concentration resulting from storm loadings and varying practices of sewer system users. Such variabilities can result in dilute discharges as well as increased plant loadings and resulting sludges. These extremes should be addressed. Improved analytical techniques are needed for the measurement of compounds such as toxics and pathogens in wastewaters, effluents, sludge, soil and crops. Overcoming major operational problems occurring as a result of design deficiencies or a lack of technical expertise in municipal wastewater treatment plants might be effectively aided by a group of in-house EPA technical experts. The establishment of such a group should be considered. Finally, the dissemination of successful research results on all of the above topics to interested parties, both inside and outside of the Agency, is of utmost importance.

3.2.3 Land Treatment and Other Natural Treatment Systems

Efforts should emphasize providing data to optimize the design and cost-effectiveness of land treatment and other natural treatment systems. Long-term water quality and ecological impacts need to be assessed for slow rate, rapid infiltration, overland flow, wetlands and other aquaculture treatment technologies. Monitoring data and evaluations are needed on the design and performance of raw wastewater applications to wetlands, water hyacinth, and polyculture systems. The state-of-the-art health assessment of land treatment systems should be completed and published as an Agency report. The following health-related issues need to be addressed: microbiological evaluation of slow-rate land treatment runoff; virus and fecal coliform die-off rates in ponds, particularly those used for preapplication treatment; required slope/residence time and dilution effects after rainfall regarding fecal coliforms in overland flow treatment, particularly with raw wastewater application; microbiological and other limitations on the reuse potential of water recovered from land treatment; human health risks due to pathogen or toxic compound accumulation through the food chain; and source identification and health risks of pathogens in natural systems from non-sewage sources (e.g., from domestic or wild animals). In addition to the health-related aspects of such treatment systems, ecological impacts must be determined. An ecological assessment of natural and artificial wetlands involved in wastewater treatment should be performed along with additional studies to evaluate the impact on wildlife which feed in and around land treatment and other natural treatment systems.

3.2.4 Innovative and Alternative Technology Program Support

An active innovative and alternative technology (I/A) program is important to long-range improvements in the economic and technological areas of the wastewater treatment field. Expansion of this program is needed. It is imperative to remain informed of operating projects in the I/A program in order to follow up on promising technologies with any required complementary research activities. Detailed evaluations of selected systems constructed through the I/A program need to be performed (in response to Section 105(j) of the Clean Water Act) in order to transfer new technology to the municipal sector. Assessments of newer, emerging technologies should be continued. Also, the continued high level of responsiveness in reviewing I/A proposals from the Regional Offices is recommended.

3.2.5 Sludge Management

Processing and treatment. Operators of many existing sludge processing systems are in need of information that would improve system performance and reliability, and decrease O&M problems, energy requirements and costs. The operation of new de-watering units, such as filter presses and belts, require information on the solution of operating problems as well as on the use of conditioning chemicals and chemical feed systems.

Conversion processes. Rather than studying expensive extraction methods to remove lead, cadmium and other trace metals from municipal sludge, more emphasis should be placed on making these elements less available for uptake by vegetation when sludge is applied to the land. Several areas of thermal conversion require emphasis. The development and evaluation of emission control systems is needed to provide reliable, efficient and less expensive thermal conversion of sludge in areas with major air quality problems. The best available techniques need to be identified for energy recovery from new and retrofitted thermal processing and co-disposal systems. This should include a comprehensive economic study of the co-disposal options, including the cost of adding sludge-handling capabilities to existing incinerators and accepting sludge in solid waste resource recovery projects. Detailed evaluations are needed of full-scale conversion systems such as incineration with energy recovery, pyrolysis, co-disposal and composting.

Disposal and utilization. The state-of-the-art health assessment of land application of municipal sludge should be completed and published as an Agency report. The fate and effects of toxic organic compounds in sludges, particularly when applied to agricultural land, must be more clearly defined. Good management practices and improved designs must be developed for "contaminated" sludges. To achieve this, possible beneficial approaches to non-agricultural uses (e.g., production of biomass for energy conversion, reclamation of drastically-disturbed land and use in silviculture) and disposal practices such as high-rate surface application to dedicated sites and landfills should be studied. Data are needed on total and available levels of pathogens and toxic compounds in soil, runoff, groundwater and crops from sites receiving sludge treated at various levels of stabilization (including no stabilization) and using various land application techniques. Microbiological or other health risks associated with grazing animals on land application sites need to be addressed. A simple technique for identifying pathogens in runoff which do not originate from the land-applied sludge (e.g., from domestic or wild animals) should be developed along with an assessment of any related health risks. An ecological assessment of land application of sludge is also needed. Finally, specific places (e.g., Ohio Farm Bureau Project sites for cropland application, Penn State University/Penn DER Project sites for land application) should be identified where detailed sludge reuse studies have been performed. This information should be provided to others in a manner that can help to establish full-scale or pilot projects, using 201 funds or in joint funding with DOE, TVA, DOI/Office of Surface Mining, USDA, etc.

3.2.6 Small Wastewater Systems

Monitoring and evaluation of carefully selected small wastewater system 201 projects are needed. The present on-site system research program appears to be very responsive to OWPO needs. Emphasis should be placed on gathering data pertaining to the cost, design, performance, management and reliability of on-site systems. These data will be used to assist with future updates of the on-site design manual. The establishment of a capability to respond to requests for technical assistance should be considered. Existing on-site projects that have used current design information should be evaluated. The monitoring of new on-site systems, particularly community drainage fields, should be performed to evaluate the impact of these sytems on groundwater. In this regard, a predictive tool for on-site system impact on groundwater is needed, particularly for toxic compounds and pathogens.

A study is needed of the low pressure, subsurface soil distribution system developed at North Carolina State University by Dr. Robert Carlile. Appropriate applications, effectiveness, and costs should be included. Also, existing subsurface aerobic systems need to be evaluated for performance, effectiveness and costs.

A study of decentralized approaches to wastewater management is needed, particularly for the extension and upgrading of sytems built with construction grants funding but now requiring additional capacity due to new development. Cost effectiveness and institutional considerations should be examined for alternatives to a second round of construction grants. A comparison of alternative wastewater systems and conventional gravity sewers is needed. This should be done on a present worth/annual equivalent basis for construction, operation and maintenance costs. Completed small community sewering projects should be compared to step or grinder pump pressure systems and/or small diameter gravity sewers as appropriate to each project. Also, a comparison of actual costs, new construction and O&M from completed projects is needed for alternative conveyance systems.

Finally, a feasibilty study and possibly the preparation of a concept design manual are needed for alternative systems. This manual should consider a range of situations requiring pollution control with possible solutions and designs.

3.2.7 National Urban Runoff Program

Two major research needs have been cited for this program. The first is research on bacterial indicators that correlate urban runoff with human health effects. This in turn would allow the development of microbial treatment criteria for stormwater discharges. These criteria should be health-related and based on risk assessments.

The second requirement is the development of exposure-response curves for toxic pollutants entering the receiving water in storm runoff. These curves should show the LC_{50} versus the duration of the runoff event for each toxic pollutant or indicator organism. As opposed to commonly used toxicity tests which employ a standard exposure time, this research should address the fact that storm events result in significant temporal variations in pollutant exposure. Currently, the greatest interest lies in assessments for lead, cadmium and mercury.

Additional research which is needed includes studies on the long-term impacts of stormwater runoff, comparisons of loadings from urban runoff with those from other sources and determinations of the ultimate fate of these pollutants. The testing of new control technologies should be completed as quickly as possible and the results published and disseminated.

Table 3.1

SUMMARY OF RESEARCH NEEDS

Office of Water Program Operations

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
1. Process Development	a) Finalize disinfection manual	b) Technology transfer of alternative disinfection information c) Improved toxics and pathogen analytical techniques**	
2. Toxic Pollutants Control	a) Assess and compare all technologies for toxics removal/destruction b) Re-examine criteria for Salmonella c) Effect of toxics on stream quality and use*	d) In-plant toxics removal processes e) Publish sludge toxics fixation and extraction information	
3. Municipal Sludge Management	a) Finalize state of the art health assessment for land application and start followup studies b) Finalize land application design manual c) Evaluate full scale conversion systems including special studies of thermal conversion d) Technical backup for 405 regulations e) New project applications of available sludge reuse information	f) EP toxicity testing g) Air emission controls for thermal conversion h) Economics of co-disposal i) Composting guide for small communities	j) Good management practices for contaminated sludges k) Improved processing information l) Multi media relative risk evaluations m) Ecological assessment of land application* n) Bulking agents for composting o) Pathogen die-off and risks of land application
4. Plant Operations And Design	a) Design information series for professional society impact	b) Develop design guidelines for new and improved processes c) Update design information guidelines	d) Atypical wastewater treatment e) Form technical assistance groups for POTWs

*Related to Water Quality Research Committee **Related to EMSL Committee

Table 3.1

SUMMARY OF RESEARCH NEEDS
Office of Water Program Operations

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
5. Land Application Of Wastewater And Aquaculture	a) Finalize and publish state of the art health assessment and undertake followup studies b) Ecological assessment of wetlands*	c) Pathogen die-off rates in ponds d) Update design, performance and long-term effects information e) Determine slope/residence time for overland flow f) Ecological studies of land application and other natural treatment systems	g) Effect of rainfall on pathogens h) Pathogen and other constraints on water reuse after land treatment i) Health risks due to food chain transfer of toxics or pathogens
6. Urban Runoff	a) I/I evaluation and sewer rehabilitation b) Develop methodology for evaluating CSO control impacts* c) Design manual on available CSO controls d) Develop separate storm sewer wet weather pathogen criteria e) Fate and effects of toxics in CSOs, urban runoff and recycled wastewaters and sludges*	f) Technology transfer for I/I program g) Evaluate CSO control impacts* h) Evaluate urban runoff impacts and assess level of problem i) Toxics exposure/response curves for time-variant systems	j) Assess available urban runoff controls k) Stormwater control technologies report
7. Energy	a) Energy reduction techniques for high energy components of treatment b) Energy conservation, recovery and production studies	c) Thermal conversion, digestion, and methane recovery/cleanup and other hardware technology links d) Natural systems for energy use reduction	e) Benefical reuse/recycle of sludge and wastewater for biomass production

*Related to Water Quality Research Committee

**Related to EMSL Committee

Table 3.1

SUMMARY OF RESEARCH NEEDS

Office of Water Program Operations

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
8. Small Wastewater Flows	a) Provide increased technical assistance b) Evaluate projects using current design information c) Complete septage manual	d) State of the art summary of large subsurface drainfields e) Improve cost, design, performance and reliability information f) Develop facility maintenance and and impact monitoring methods	g) Evaluate low pressure subsurface soil distribution and small subsurface aerobic systems h) Compare costs of gravity sewers vs. alternative systems
9. Innovative And Alternative Technology	a) Expand active I/A effort b) Technology transfer and conduct national symposia	c) Identify and support promising technologies d) Emerging technology assessments	e) Regional and state project reviews f) Detailed evaluation of selected I/A Systems

*Related to Water Quality Research Committee **Related to EMSL Committee

3.3 OFFICE OF WATER REGULATIONS AND STANDARDS RESEARCH REQUIREMENTS

The Office of Water Regulations and Standards (OWRS) is responsible for the development of water quality criteria and standards, and for the issuance and defense of industrial water pollution control regulations in the form of effluent guidelines and limitations for a variety of industrial categories. This office is also responsible for determining water quality trends, pollutant problem areas and causes, and for making control recommendations. It also provides guidance on the implementation of water quality standards, waste load allocations and the use of water quality criteria. Thus, the interface between OWRS and the Municipal Wastewater Research Committee lies in several areas including pretreatment of industrial effluents, the determination of the presence and effects of toxic pollutants and pathogens in POTW discharges, urban runoff and combined sewer overflows, and the effects of toxic pollutants on municipal treatment processes and in municipal sludges. The research requirements of OWRS in support of its objectives are described below under the general research categories, and outlined in Table 3.2.

3.3.1 Process Development

As new processes to treat wastewater are developed, the removal capabilities for toxic compounds must be defined and identified. This knowledge of technological capabilities will assist in the formulation of effluent guidelines and waste load allocations.

3.3.2 Toxic Pollutants Control

Of primary importance is the need to determine, in quantitative terms, the source, fate and effects of toxic compounds discharged from POTWs to the aquatic environment, and the development of techniques for determining the human health effects. Source information on priority pollutants in the urban environment needs to include, for each compound, the amount discharged to and from the treatment plant and from other points in the system such as combined sewer overflows. The development of methodologies to determine the reintroduction of toxic compounds from the sediment phase to the water column is needed to quantify the fate of these substances. This capability is needed in order to discern whether long-term buildups of toxic compounds in aquatic environments will create negative impacts in the future despite the lack of observable effects at present. Also, a quantitative methodology to determine the effects of discharged toxic compounds on aquatic life is needed to provide a basis for setting water quality criteria and standards and for establishing waste load allocations. In addition to these efforts, better and less costly test indicators and measurement methods for toxic compounds need to be developed.

Research is also needed on the control of toxic compounds as they relate to municipal wastewater treatment plants. Studies of toxic compounds inhibiting plant performance are necessary to make decisions on pretreatment levels and credits. Basic incompatibilities of given compounds with municipal treatment processes should be identified. Organics and metals in addition to cadmium should be studied, with emphasis on those with known inhibitory and toxic characteristics followed by those known to occur in the largest quantities. In terms of removal and cost, the relative effectiveness of secondary treatment, BAT, and source control should be compared. Best management practices should be identified and evaluated. Institutional impediments to pretreatment must also be analyzed. Influent loadings to POTWs and treatability need to be determined for toxic compounds. Also, toxic compound material balances around a POTW are needed. This should include all air, liquid and solid streams. Finally, a comparison is needed of toxic compound input to the environment as a function of point versus non-point sources.

3.3.3 Municipal Sludge Management

The development of toxicity and health effect criteria for metals, toxic organic compounds and pathogens in sludge is of prime importance in order to determine their impact on the beneficial use of sludge. A summary document of all available literature on the short-term and chronic toxic effects of sludge use and disposal would be helpful. Also, the effect of pretreatment for toxic compounds on sludge quality should be determined. This is needed for industrial environmental assessments and will be used in POTW material balances and in regulatory impact analyses.

3.3.4 Plant Operations and Design

The possibility of creating toxic compounds as a result of municipal wastewater treatment (e.g., super-chlorination) must be identified along with remedial approaches. This is needed to help establish priority of pollutants for additional inhibition studies and to complete material balances.

3.3.5 Land Application of Wastewater and Aquaculture

The groundwater impact of toxic compounds from the land application of wastewaters and plant effluents must be determined as a component to determining pretreatement requirements. Such technical information is also needed for the development of criteria, guidance and regulations on application practices.

3.3.6 Urban Runoff

A study identifying and relating toxic compounds in urban runoff to the biological integrity of receiving waters and effects on human health is of highest priority. To do this, a methodology is needed to study storm event-related toxicant input, biological response and how this is related to human health. Basically this amounts to an ecological measure of storm events. In order to resolve wet weather flow criteria, toxic pollutant loadings from combined sewer overflows must be determined along with the impact of storm event loadings on POTWs. The effectiveness of toxic compound removal in some of the more conventional runoff pollution control methods should be evaluated. A cooperative effort between the Program Offices and ORD is needed to quantify the sources and impacts of these pollutants in urban runoff and sewer overflows. The effect of atmospheric deposition should be included in this effort. Such effects would result from direct deposition of toxic compounds to receiving waters as well as from direct inputs via land deposition and subsequent transport (in proportion to acidity) to surface and groundwaters.

From an area-wide perspective, methodologies need to be identified which are capable of assessing runoff-related problems and solutions for an entire urban complex. Toxic compound material balances are needed for this.

Quantitatively, the effects of urban runoff on water quality must be defined, and evaluation methodology is needed to do this. Once urban runoff problems are identified, it will be necessary to know what control approaches, particularly BMPs, are available. The effectiveness of runoff controls and the economic impacts of BMPs should be evaluated on a continual basis.

3.3.7 Innovative and Alternative Technology

The performance of treatment systems on toxic compound removal needs to be evaluated as new technologies emerge and are tested in operating facilities.

Table 3.2

SUMMARY OF RESEARCH NEEDS
Office of Water Regulation and Standards

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
1. Process Development	a) Removal capabilities and effects associated with new processes		
2. Toxic Pollutants Control	a) Effects of POTW discharges on aquatic life b) Fate in receiving waters of POTW discharges (e.g., sediment buildup and release) c) Determine sources of priority pollutants d) Test indicators and measurement methods e) Inhibition studies of toxics on POTWs f) Toxics material balances on all POTW streams	g) Treatability studies and influent determination h) BAT impact of receiving streams i) Evaluate BMPs j) Protocols for sampling and testing k) Compare 2^{o} treatment to source control l) Compare point vs. nonpoint sources	m) Analyze institutional impediments to pretreatment
3. Municipal Sludge Management	a) Development of sludge criteria for metals and organics b) Effect of pretreatment on sludge quality		
4. Plant Operations And Design	a) Determine toxics formed as a result of POTW processes (e.g., superchlorination)		
5. Land Application Of Wastewater and Aquaculture	a) Determine groundwater impacts of toxics		

Table 3.2

SUMMARY OF RESEARCH NEEDS
Office of Water Regulation and Standards

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
6. Urban Runoff	a) Effects of toxics in urban runoff on stream biology b) Data for wet weather flow criteria and standards - impact on POTWs and CSOs c) Evaluate effectiveness of conventional controls d) Cooperative effort to quantify and compare pollutant sources and impacts e) Effect of atmospheric deposition f) Areawide evaluation of urban complex for problems and solutions		
7. Energy			
8. Small Wastewater Flows			
9. Innovative And Alternative Technology	a) Performance on toxics (concentration and effects)		

3.4 OFFICE OF SOLID WASTE RESEARCH REQUIREMENTS

The Office of Solid Waste (OSW) is involved chiefly in the implementation of programs under the Resource Conservation and Recovery Act of 1976 (RCRA) and the Clean Water Act of 1977 (CWA). In an effort to protect health and the environment, while promoting the conservation of valuable materials and resources, RCRA requires the establishment of a Federal hazardous waste control program, issuance of criteria to define acceptable solid waste disposal practices and a phase-out of unacceptable facilities such as "open dumps". The Clean Water Act addresses the fate of toxics in POTWs and the establishment of guidelines on the proper use and disposal of municipal sludges by POTWs (Sections 307 and 405). As part of the comprehensive sludge management effort (CWA Section 405), the main focus of attention for OSW has been the finalization of land application criteria under RCRA Section 4004 and CWA Section 405 and regulations for the "Distribution and Marketing of Sludge Products Regulations."

ORD support under the category of muncipal sludge management will be required by OSW over the next few years in the areas described below and outlined in Table 3.3. Required dates for output of results are given in parentheses.

3.4.1 Pathogens in Sludge

EPA's Office of Research and Development must determine the feasibility of using a mixed microbe culture or soil inoculum to prevent the re-growth of pathogenic bacteria in sludge products after treatment by composting, heat drying, pasteurization, irradiation or other techniques (December 1981). Correlations between the rate of disease infection and sludge use must also be identified. This study should include 20 or more communities where sludge use is an established practice and should entail a review of local medical facility records and consultation with local physicians on incidence of various related infections. Analyses of the pathogens present in the sludges used and in the soils at application sites and an evaluation of the sludge treatment processes should also be included (December 1981). Work must also be done to determine whether organisms such as parasitic ova and cysts and salmonella are present in sludge-derived fertilizers and soil conditioner products that are currently available to the public (March 1982). In addition, soil and vegetation analyses must be made for the presence of pathogens in areas where sludge and/or slurries (including those from meat-packing and dairy plants) are being used to irrigate food cropland, animal fodder cropland and pastureland. This study should include at least 20 sites of varying geographic and climatic characteristics (March 1982). These projects are high priority needs. Requirements in this area which are not quite as critical include an evaluation of the effectiveness of various sludge treatment processes in reducing pathogens (June 1982). Suggestions for improvements in processing techniques are needed as well. In addition, home garden produce and soils must be analyzed for the presence of parasitic ova and cysts and salmonella in areas where sludge products are sold or given to individual gardeners (June 1982). Areas studied should be of varying geographic and climatic character. Finally, more reliable and less costly techniques for detecting viruses and parasites in sludge must be developed (June 1982).

3.4.2 Fate and Persistence of PCBs

High priority research requirements in this area include field studies of degradation rates and half-life of PCBs as a component of sludge and soil. The ability of this compound to volatilize from soil or sludge to the surface of crops and the degree of a sludge's PCB adherence to typical pasture and forage crops should be studied. Uptake of PCBs by all types of root crops (particularly potatoes, turnips, radishes and beets), and retention and concentration of PCBs in the beef and milk fat of animals grazing on sludge-amended soils are other areas of high priority (December 1981). A mass balance study for animals raised for food should be one element of this effort. Actual PCB ingestion over the life of the animal as it relates to accumulation in edible portions should be considered.

A study on additions of PCB to field and garden soils, and the development of better techniques for analyzing sludge samples for the presence of this and other organic compounds (March 1982) have been specified as medium priority needs.

3.4.3 Sludge Adherence to Crops

The adherence of sludge to crops is another area which requires research. A project should be initiated to evaluate the degree to which sludge, and its chemical or pathogenic constituents, adheres to various types of forage and vegetable crops, under various types of sludge land application. A medium priority has been assigned to this work.

3.4.4 Fate and Effects of Lead in Sludge

Lead is another compound of major concern to OSW. A project should be undertaken to determine the sensitivity of typical home fruit and vegetable garden crops to lead (December 1981). Topics to be explored include the types of crops which tend to accumulate lead, the effects of soil characteristics such as pH, CEC, P content, etc., on uptake levels, and the degree to which uptake is affected by the chemical form of lead in the soil. In addition, the concentration and availability of lead in soils as a result of sludge application to land must be determined (March 1982). Typical background concentrations for various residential areas are: rural 0-100 mg/kg; urban 100-1000 mg/kg, and urban/central city 1000-3000 mg/kg. The degree to which dilution occurs in high-lead soils when low-lead sludge is applied, duration of this effect and the rate of horizontal or vertical migration of lead in soils should be components of this study. All of these are high-priority projects.

One medium-priority need exists in this area and that is a quality assurance comparison of various analytical techniques for heavy metals (lead, cadmium, copper, nickel, zinc, etc.) in sludges, soils and plant tissues. Some techniques which should be studied include nitric acid digestion and AA analysis, X-ray fluorescence, dithizone extraction and colorimetry, and nitric-perchloric acid digestion and tantalum boat technique using standard additions and others (no requested date).

3.4.5 Land Application to Non-Food-Chain Croplands

Data are needed on the use of non-food-chain croplands of sludge with concentrations of toxic elements which would preclude them from food chain landspreading, but would not necessarily define them as hazardous wastes. Non-food-chain lands would include woodlots, energy and ornamental crop sites, and reclamation projects. Specific requirements of immediate concern are for studies which address the effect of sludge application on the growth of such crops under various soil and site conditions and the level of phytotoxic metals which can be tolerated, particularly by ornamentals. Also needed is a literature review for work which identifies site characteristics necessary for preventing degradation of ground and surface water (March 1982).

3.4.6 Plant Uptake of Toxic Organics and Heavy Metals

Plant uptake of toxic organics (other than PCBs) and heavy metals (other than cadmium, copper, nickel, zinc, chromium and lead) in sludge, as well as basic research on the mechanisms (such as soil chemistry and metal interactions) which affect uptake of heavy metals must also be studied (no requested date). This research is of medium priority. A low-priority requirement is for the investigation of cadmium uptake by tobacco, peanuts, citrus fruits, and leafy vegetables (no requested date).

3.4.7 Epidemiological Studies

An epidemiological study designed to detect the potential human health effects, both immediate and chronic, resulting from exposure to toxic metals (especially cadmium and lead) and toxic organics (particularly PCBs) in sludge must be initiated. The subjects would be residents of an area where sludge distribution and marketing practices have been in existence. The study should focus on current problem areas where high soil concentrations of the contaminants mentioned above have been detected, and sludge use may be the source of contamination (no requested date). This is of medium priority.

3.4.8 Dietary Cadmium Uptake

A comparison should be made of the two methods presently used for estimating current dietary cadmium (and other metals) exposure. The two methods, fecal excretion studies and market basket surveys, should be evaluated for relative strengths, weaknesses and reliability. A medium level of priority is assigned to this effort.

3.4.9 Disposal of Septic Tank Pumpings

Current methods of disposal for septic tank pumpings should be investigated as a medium-priority project. Pathogen, heavy metal and persistent organics concentrations must be characterized. Research related to the potential for groundwater contamination through land application, direct injection and trenching of septic tank pumpings must be reviewed (no requested date).

Table 3.3

SUMMARY OF RESEARCH NEEDS
Office of Solid Waste

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
1. Process Development			
2. Toxic Pollutants Control			
3. Municipal Sludge Management	Pathogens in sludge: a) Regrowth prevention b) Land application and disease correlation c) Analyze sludge derived fertilizers d) Study areas where sludge is applied to land PCBs in sludge: e) Adherence to crops f) Uptake by root crops g) Accumulation in beef and milk fat Lead in sludge: h) Accumulation in soils i) Land application on non food chain crop lands	Pathogens in sludge: j) Evaluate POTW processes for pathogen reduction k) Home garden studies l) Improve virus and parasite detection techniques PCBs in sludge: m) Home garden studies n) Better analytical techniques o) Plant uptake of additional organics and trace metals p) Evaluate analytical techniques for trace metals in sludge, soils and plant tissues q) Sludge adherence to crops r) Plant uptake mechanisms for trace metals s) Epidemiological studies in areas of sludge-amended soils t) Compare current methods for dietary Cd exposure evaluations	u) Cd uptake by leafy plants, fruits and peanuts v) Plant uptake studies
4. Plant Operations And Design			

Table 3.3

SUMMARY OF RESEARCH NEEDS

Office of Solid Waste

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
5. Land Application Of Wastewater And Aquaculture			
6. Urban Runoff			
7. Energy			
8. Small Wastewater Flows		a) Characterize contaminants in septic tank pumpings b) Effect of septage disposal practices	
9. Innovative And Alternative Technology			

3.5 OFFICE OF PESTICIDES AND TOXIC SUBSTANCES RESEARCH REQUIREMENTS

Although much of the effort of the Office of Pesticides and Toxic Substances (OPTS) is concerned with the testing and regulation of chemicals produced by industry, some of its work addresses the presence of toxic compounds in municipal wastewater treatment facilities. This work is the responsibility of the Exposure Evaluation Division and the Exposure Assessment Branch and is concerned primarily with determining material balances for toxic compounds in municipal treatment plants. The objective is to be in a position to decide whether or not there is a sufficient quantity of toxic compounds leaving a POTW, and by what route, to constitute a problem in the environment. The research needs of this Office are presented below and outlined in Table 3.4.

3.5.1 Toxic Pollutants Control

All process streams (liquid, solid and air) are routes for transport of toxic compounds through treatment facilities. Basically, monitoring data on priority pollutants from all inlet and outlet points in POTWs are needed to determine the quantities leaving a plant and what route they take. Such data are necessary to determine the amount of toxic compounds which are discharged into the environment and their routes of exposure. Monitoring of receiving water is also needed to determine this. Moreover, the formation of any toxic compounds within a POTW, perhaps as a result of treatment processes, must be determined to complete a material balance.

3.5.2 Municipal Sludge Management

In addition to data on treated effluents, baseline data are needed to determine the presence and quantity of toxic compounds in sludge and, in particular, the fate of toxics from land-applied sludge and incinerator emissions.

3.5.3 Urban Runoff

Another objective of this office is to determine material balances for urban runoff. To do this, data on the presence and quantity of toxic compounds are needed.

Table 3.4

SUMMARY OF RESEARCH NEEDS
Office of Pesticides and Toxic Substances

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
1. Process Development			
2. Toxic Pollutants Control	a) Monitor all inlet/outlet process streams for toxics b) Monitor receiving waters below POTW outfalls	c) Formation of toxics as a result of POTW operations	
3. Municipal Sludge Management		a) Presence and quantity of toxics in sludge b) Fate of toxics from land-applied sludge c) Fate of toxics from incineration	
4. Plant Operations And Design			
5. Land Application Of Wastewater And Aquaculture			
6. Urban Runoff	a) Data for toxics material balances		
7. Energy			
8. Small Wastewater Flows			
9. Innovative and Alternative Technology			

3.6 OFFICE OF WATER ENFORCEMENT RESEARCH REQUIREMENTS

The major municipal area of concern for this office is compliance with pretreatment regulations. The 1977 Clean Water Act mandated that POTWs develop programs to enforce the EPA's National Pretreatment Requirements. Since then, these programs have been shifting toward the local level. Enforcement's efforts will therefore be directed toward helping to rework state and local programs, considering requests for modification of pretreatment standards and modifying municipal permits to incorporate pretreatment requirements. In addition, the Office of Water Enforcement (OWE) is involved in updating, rewriting and/or producing manuals for use by the POTW operators and Regional Offices on such topics as residuals and removal credits.

Chief among the research needs for OWE (Table 3.5) is the development of methodologies to monitor for compliance with pretreatment regulations. Several approaches to this objective should be pursued. The development of surrogate techniques and indicator parameters is one area which could reduce the costs of effluent monitoring. As an alternative to effluent monitoring, the possibility for routine plant visits and process performance checks should be studied. Remote sensing and better flow measurement methodologies would also aid OWE functions. In addition, data from monitoring studies must be collected and verified. In the case of OWRS's 40 POTW study, OWE would like to see verification of the approach used with regard to combined sewer overflows as well as other sources. Monitoring data is needed to fill gaps in current knowledge with regard to the sources of specific toxics (i.e., are they of industrial, residential or commercial origin?). The possible need for regulating non-industrial and non-residential sources of toxic pollutants (e.g., commercial laboratories) must also be addressed. This, again, would require monitoring data.

Regarding toxic compound controls, assessment criteria are needed for Best Management Practices both for industries using pretreatment and for urban runoff controls. Also data analysis and tools for evaluation of wet weather problems are needed. Finally, cost effective technologies for the control of combined sewer overflows must be developed.

Table 3.5

SUMMARY OF RESEARCH NEEDS

Office of Water Enforcement

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
1. Process Development			
2. Toxic Pollutants Control	a) Assessment criteria for pretreatment BMPs b) Better effluent monitoring methods c) Alternatives to effluent monitoring for assessing compliance d) Identify and monitor source of specific toxics		
3. Municipal Sludge Management			
4. Plant Operations And Design			a) Develop improved flow measurement methods b) Provide technical support on demand for instrumentation
5. Land Application Of Wastewater And Aquaculture			
6. Urban Runoff	a) Assessment criteria for BMPs b) Cooperative effort to quantify sources and impacts c) Data analysis and tools for wet weather problems	d) Verification of CSO approach and results for 40 city study e) Develop cost effective CSO control technologies	
7. Energy			

Table 3.5

SUMMARY OF RESEARCH NEEDS

Office of Water Enforcement

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
8. Small Wastewater Flows			
9. Innovative And Alternative Technology			
10. General	a) Provide technical support, on demand, for instrumentation b) Develop improved flow measurement methods c) Develop remote sensing methods (discharges, collection systems, impacts, etc.)		

3.7 REGIONAL OFFICE RESEARCH REQUIREMENTS

The 10 Regional Offices provide decentralized implementation and oversight of Agency programs. Functions include local permitting and enforcement activities as well as the administration of construction grants. These offices interface directly with state, regional and local groups. As each Region differs demographically, geologically and climatologically, their research needs are quite diverse and often very specific in that they reflect the particular problems arising in each Region. In a number of areas, however, common needs exist which reflect national trends and interests. For example, the development of a wastewater disinfection manual, safe landspreading techniques, less energy-intensive wastewater treatment and sludge disposal practices, and information on the treatment of small wastewater flows were expressed as prominent needs in a number of regions. Specific needs are described by Region and research area in the narrative which follows and in Table 3.6.

3.7.1 Region I

Process development. Three requirements have been specified in this area, both of which are high priority items. The first is a field investigation of operating "Phostrip" wastewater treatment facilities. The Phostrip process uses microorganisms already present in wastewater to concentrate phosphorus into a substream which can be removed by precipitation techniques. The second project involves the evaluation of high-energy electron irradiation of wastewater.

Another high-priority research requirement is an assessment of the impact of conservation on the design and operation of both POTWs and sewers.

Toxic pollutants control. Information on POTW and on-site non-industrial toxics must be developed. This is a high-priority research requirement.

Municipal sludge management. The predominant research needs in this area include developing environmentally acceptable land spreading and land filling methods. Demonstrations and case studies must be conducted and technology transfer to the state and local level should be initiated.

In addition, further information is required on by-products formed during the Purifax process. Data on high-energy electron irradiation of sludge is needed, as are improved methods of sludge processing and disposal for small POTWs. The latter project must address the issues of: chemical conditioning of sludge prior to discharge to drying beds; labor saving methods to remove dried sludge with a minimum of damage to the bed; use of non-mechanical dewatering systems and experimentation in the disposal of semi-dried sludge through continuous application to a controlled area followed by mixing with soil.

A less critical area is the production of energy from sludge. Since both large urban areas and rural areas with an extensive wood industry are located in this Region (Region I), energy recovery from sludge, solid waste and/or wood waste might prove to be worthy ventures.

Plant operations and design. All research projects specified for this area are high priority needs. The first is the development of methods to reduce energy consumption at POTWs. In addition, methods for improving operational efficiency and for identifying design deficiencies in treatment plants must be developed. A useful tool requested by this Region is a set of computer models of biological wastewater treatment processes. Adequate simulation of these processes is needed to test the effects of proposed control alternatives for: training operators, implementing open-loop process control and providing input data for continuously-responsive controls so that plant operating efficiency could be maximized.

Land application of wastewater and aquaculture. The ultimate fate of nitrates, sodium and heavy metals, and the lateral and vertical transport of pollutants must be studied. This will help determine safe distances from application sites to water supplies. In addition, methods of sampling at aquifer interfaces should be developed. It is also required that design criteria and cost data for evapotranspiration systems be compiled. These are high-priority areas which require immediate attention. A specified medium priority is the study of nutrient retention in fast percolation lake soils.

Urban runoff. Three research requirements were specified as being of primary importance in this category. The first is a demonstration of sewer flushing on large sewers. Such a field study is required in order to ascertain the feasibility of using this method to mitigate the effects of combined sewer overflows (CSO). A demonstration should also be conducted of micro-screening with high-rate disinfection. In addition, innovative ways to optimize the size and operation of CSO facilities are needed.

Technical support on 201 projects for CSO control is currently being offered by ORD. Provisions should be made for continuation of this support. A medium priority is assigned to this need.

Small wastewater flows. Septage treatment and disposal technology is an area of great concern in Region I. Demonstration and case studies providing actual field data on capital and operating costs and performance experience for an appropriate range of alternatives should be conducted. Once this information is available, it should be disseminated to design engineers and state and local officials. Two other high-priority needs are the development of a methodology for predicting the life of a leaching field, and the study of controls for the acid lime sidestream from septage pretreatment.

Innovative and alternative technology. All research needs specified under this topic have been assigned a high priority by the Regional Office. The projects required are: the creation of procedures for post-construction verification of energy savings; the formulation of criteria for justification of 100 percent replacement; and, support for the I/A clearinghouse.

3.7.2 Region II

Process development. Although this is a low priority, Region II would like to see work done on minimizing the impact of re-use for cooling on the biota.

Municipal sludge management. Since ocean dumping of sludge (which is practiced in this Region) must be phased out by 1981, the development and testing of cost-effective, environmentally and aesthetically acceptable disposal methods are of grave concern. Of particular interest are new European technologies. Information to document their efficiency, however, is not available and should be developed. Other technologies which should be investigated include land spreading and thermal destruction. An evaluation should be made of their applicability to urban area sludges.

Land application of wastewater and aquaculture. One medium-priority need was specified in this area: a study of the effect of wastewater injection on groundwater quality.

Urban runoff. On a medium level of priority is the development of documentation on the short- and long-term impacts of runoff.

Small wastewater flows. Of uppermost importance is the need for information on the treatment and disposal of septage. In particular, the organics loading from the average household, the loading which is acceptable for septic tank treatment in a given soil and methods for treating organic wastes to bring the organics loading to an acceptable level must be ascertained.

3.7.3 Region III

Process development. Although chlorination is a common practice, excessive use of the chemical can disturb water quality. Region III is, therefore, interested in a set of well-documented guidelines which will show the impact on public health of lowered chlorine levels in effluents. The guidelines should also address seasonal chlorination, for in some areas, chlorination may only be needed during the summer months.

3.7.4 Region IV

Process development. One need was noted in this area and has been assigned a high priority: the development of methods to correct nitrate accumulation in groundwater.

Plant operations and design. The chief concerns in this area include the organization of refresher courses for plant operators, the evaluation (for cost-effectiveness and efficiency) of different types of clarifiers, and the development of guidelines that can be used to assist design engineers in selecting unit processes which are best suited to particular wastewaters.

More specific POTW design criteria are required, but are less critical than the three needs specified above.

Land application of wastewater and aquaculture. A high priority need in this area is to determine the health implications of land treatment of wastewater and wastewater sludges.

Urban runoff. Data collection for storm events is of prime importance in this area.

Small wastewater flows. The relationships of septic drainfields and lagoon leachates to various soil types in the coastal zone must be characterized. Groundwater gradients and movement of leachates through soils to surface waters should be determined in the coastal plain. Changes in leachate concentrations with time and distance in coastal plain soils must be addressed. In addition, predictive models for contaminant movements in such soils should be developed. This work is high priority. Studying the effect of small flows on wetland water quality (a medium-priority need) was also specified.

3.7.5 Region V

Technology transfer. The continuation of the technology transfer program was designated as a high-priority need. The program would fulfill needs in a number of different research areas. Specific outputs requested by Region V include seminars on the following topics:

- Bioassays: Biomonitoring of Wastewater Effluents.
- Agricultural BMP Alternative to AWT.
- Conducting Hazardous Waste Inspections Safely.
- Treatment of Industrial Wastes to Allow Non-hazardous Disposal.
- Sludge Treatment and Disposal.
- The Latest Concepts in Innovative and Alternative Technology.
- Atmospheric Hydrocarbons.
- Analytical Methods for Trace Organic Detection in Water and Fish.
- Automated Wastewater Monitoring & Management Systems.
- Advanced Methods and Approaches for Monitoring Water Quality.
- Advanced Methods and Approaches for Monitoring Air Quality.
- Aerial Monitoring of Hazardous Waste Sites and Hazardous Spills.
- The Impact of Fuel Switching, Can We Do It Without Harming the Environment.
- Control of Trihalomethane Formation in Drinking Water Treatment.

Process development. Chlorination and alternative disinfection methods must be studied on a high-priority basis. Specific outputs should include: identification of suitable criteria for deciding whether or not disinfection should be required for a given effluent; evaluation of chlorine and other agents with regard to the criteria for disinfection and investigation of alternatives to chlorine for potential toxic substance contamination and formation of toxic byproducts.

Toxic pollutants control. Of prime importance is the need for models which predict the partitioning of toxic compounds between effluents and sludges in municipal treatment plants.

Municipal sludge management. The monitoring of cadmium in sludge-amended soils is the chief concern in this area.

Plant operations and design. Guidelines are needed which define the sensitive factor determining whether or not advanced wastewater treatment (AWT) is justified. In addition, accurate, realistic simulation techniques are required to make an AWT determination. Many such techniques are available although each has its drawbacks. A literature search is needed to find those key parameters which will determine the best choice among alternative water quality simulation techniques. This work is high priority.

The reliability of sand, multimedia and other final filters should be evaluated. Such studies have been given a medium-priority rating.

Land application of wastewater and aquaculture. Design data for overland flow in northern climates is a high-priority need.

Urban runoff. Of primary importance in this area is an assessment of available data for the development of wet weather flow criteria.

Small wastewater flows. The cost-effectiveness and benefits of BMPs, as well as the efficacy of dual septic tanks in series, must be determined and are of high priority.

Innovative and alternative technology. The chief need in this area is for data on the cost, performance and reliability of various I&A technologies.

3.7.6 Region VI

Municipal sludge management. The development of environmentally acceptable sludge management and disposal options is of primary importance. Of particular interest is the vermicomposting of raw sludge. One project site with a controlled and managed program is currently operating. Additional testing and documentation is required.

Small wastewater flows. A medium- priority requirement is the study of effects of small flows on wetland productivity. Other options for disposal should also be studied.

3.7.7 Region VII

Process development. Two prominent research needs were identified in this area. The first is the evaluation of design criteria relative to performance and specific site ambient conditions for rotating biological contactors (RBCs) and activated biofilters (ABF). The second is the evaluation of disinfection processes. Chlorine, chlorine compounds, chlorine in combination with other agents and ozone must be analyzed for their relative disinfection efficiencies and potential for effluent toxicity.

Municipal sludge management. An evaluation of sludge heat treatment processes should be made. This work should be a high-priority item.

Plant operations and design. A demonstration should be conducted illustrating the applicability of automation to small POTWs.

Urban runoff. Although it is a low priority, data on urban storm events would be useful to Region VII.

Small wastewater flows. The development of alternative onsite treatment options for small flows is needed, particularly for those areas where septic tanks are unsuitable. New processes should be developed and existing ones evaluated. Design guides, operating procedures manuals and cost-effectiveness information should be published and distributed. These are high-priority needs.

Land application of wastewater and aquaculture. A high-priority need in this area is to determine the fate of viruses and pathogens in sewage sludge during land application.

3.7.8 Region VIII

Process development. Two principal needs have been noted in this area. There is some concern in this Region over residual chlorine levels. Disinfection design criteria are needed which assure adequate control of pathogens while not substantially affecting water quality. Along the same lines, decay/persistence rates for chlorine in streams must be estimated.

Municipal sludge management. Acceptable practices for land application of sludges and land treatment of wastewater must be developed for the varying climates, geomorphology, geohydrology, soils and biological systems in the western United States. Quantitative descriptions of pretreatment and disinfection criteria are needed, as are guidelines for wastes which can be safely disposed through land application. These have been given a high priority.

Plant operations and design. Three projects of prime concern have been identified under this research topic. These are the formulation of design parameters for optimum clarifier performance, the improvement of supernatant quality in anaerobic digestion and an assessment of the reliability of NH_3-N reduction in cold climates.

Land application of wastewater and aquaculture. Both of the projects described under "Municipal Sludge Management" have also been listed under this category.

Innovative and alternative technology. The primary needs in this area are for the demonstration of vertical tube reactor systems and the wet oxidation of sludge. Also of high priority is an evaluation of the potential for reducing the amount of energy used in the treatment process or for recovering energy as part of the treatment process.

3.7.9 Region IX

Process development. The principal concern here is that an assessment be made of measures designed to implement conservation and reuse. A low-priority interest is the use of salt water for toilets and for groundwater protection.

Municipal sludge management. The evaluation of trade-offs between various sludge disposal systems was specified as a medium-priority need.

Small wastewater flows. Data on small-scale treatment technology is urgently needed. Specific requirements include: feasibility studies for the use of salt water oxidation ponds; cost-effectiveness analyses and health/environmental (e.g., water quality) evaluation of various small wastewater treatment systems (e.g., aquaculture, pressure sewers, septic tanks, composting toilets); the evaluation of social and economic effects on small communities of meeting treatment standards; and the study of public health acceptability, performance reliability and cost-effectiveness of on-site and alternative wastewater management systems.

3.7.10 Region X

Municipal sludge management. For small coastal communities in Region X, sludge and solid waste disposal is quite difficult. Land application cannot be used because of climatic conditions and the lack of top soil. Landfilling is costly and, because of the high rainfall rate, could lead to leachate and nuisance problems, while the use of incinerators is precluded by high fuel costs. Thus, alternative sludge disposal methods must be developed which would be cost-effective and environmentally acceptable. This work is of paramount importance to Region X. (Subsequent to the submission of these needs, Region X has requested Agency support for ecological studies of forest land application of sludge.)

Urban runoff. An urgent concern is that of excessive infiltration/inflow (I/I). Massive quantities of I/I are causing difficulty in meeting NPDES requirements. As a result, methods must be developed for alleviating these problems.

Table 3.6

SUMMARY OF RESEARCH NEEDS

Regional Offices

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
Region I 1. Process Development	a) Field investigation of "phosphostrip" installations b) High energy electron irradiation of wastewater		
2. Toxic Pollutants Control	a) Information on POTW and on-site non-industrial toxics		
3. Municipal Sludge Management	a) Environmentally acceptable land spreading/land filling methods b) More information on Purifax process byproducts c) High energy electron irradiation of sludge d) Sludge application on corn croplands (assist U. of Conn.) e) Small POTW sludge handling - improved methods		
4. Plant Operations And Design	a) Impact of conservation on POTW and sewer design and operation b) Methods to improve operational efficiency c) Methods to identify design deficiencies d) Computer models for biological wastewater treatment processes		

Table 3.6

SUMMARY OF RESEARCH NEEDS
Regional Offices

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
Region I (Cont.) 5. Land Application Of Wastewater And Aquaculture	a) Fate of nitrates, sodium and trace metals b) Lateral/vertical transport of pollutants c) Safe distances from water supplies d) Sampling methods of aquifer interfaces e) Evapotranspiration systems - design criteria and costs	f) Nutrient retention in fast percolation lake soils	
6. Urban Runoff	a) Demonstrate sewer flushing on large sewers b) Demonstrate microscreening with high rate disinfection c) Innovative ways to optimize size and operation of CSO facilities	d) Technical support on 201 CSO projects	
7. Energy	a) Develop energy production from sludge b) Methods to reduce energy consumption at POTWs		
8. Small Wastewater Flows	a) Septage treatment and disposal technology b) Methods to predict life of leaching fields c) Control of acid/lime sidestreams from septage pretreatment		

Table 3.6

SUMMARY OF RESEARCH NEEDS

Regional Offices

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
Region I (Cont.) 9. Innovative And Alternative Technology	a) Procedures for post construction evaluations of energy savings b) Criteria for justifying 100% replacement c) Support I and A clearinghouse		
Region II 1. Process Development			a) Minimize impact on biota of reuse for cooling
3. Municipal Sludge Management	a) Evaluate new European technologies b) Urban area sludges - land spreading and thermal destruction acceptability		
5. Land Application Of Wastewater And Aquaculture		a) Effect of wastewater injection on groundwater	
6. Urban Runoff		a) Short and long term impact of runoff	
8. Small Wastewater Flows	a) Information on treatment and disposal of sludge		
Region III 1. Process Development	a) Develop wastewater disinfection guidelines		
Region IV 1. Process Development	a) Methods to correct nitrate accumulation in groundwaters		

Table 3.6

SUMMARY OF RESEARCH NEEDS

Regional Offices

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
Region IV (Cont.) 4. Plant Operations And Design	a) Refresher courses for operators b) Evaluate types of clarifiers c) Guidelines to select specific unit processes	d) More specific POTW design criteria	
5. Land Application Of Wastewater And Aquaculture	a) Health implications of land treatment of wastewater and wastewater sludges		
6. Urban Runoff	a) Data collection on storm events		
8. Small Wastewater Flows	a) Evaluate lagoon septic tank seepage for coastal soils	b) Effects on wetland water quality	
Region V 1. Process Development	a) Comparison of chlorine and other disinfectants		
2. Toxic Pollutants Control	a) Predictive model for fate of chemicals in effluents and sludge b) Continue Technology Transfer program		
3. Municipal Sludge Management	a) Monitor Cd in sludge- amended soils b) Continue Technology Transfer		
4. Plant Operations And Design	a) Guidelines to justify AWT Projects b) Continue Technology Transfer	c) Reliability of sand, multimedia and other final filters	

Table 3.6

SUMMARY OF RESEARCH NEEDS

Regional Offices

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
Region V (Cont.) 5. Land Application Of Wastewater And Aquaculture	a) Design data for overland flow in northern climates		
6. Urban Runoff	a) Assessment of wet weather flow criteria		
8. Small Wastewater Flows	a) Cost effectiveness and benefits of BMPs	b) Determine efficacy of dual septic tanks in series	
9. Innovative And Alternative Technology	a) Cost, performance and reliability data for I/A processes b) Continue Technology Transfer		
Region VI 3. Municipal Sludge Management	a) Environmentally acceptable sludge management and disposal practices b) Evaluate vermicomposting		
8. Small Wastewater Flows		a) Effects on wetland productivity, other options	
Region VII 1. Process Development	a) Evaluate Biodisc and ABF processes b) Evaluate disinfection processes		
3. Municipal Sludge Management	a) Evaluate sludge heat treatment process		
4. Plant Operations And Design	a) Demonstrate small POTW automation		

Table 3.6

SUMMARY OF RESEARCH NEEDS

Regional Offices

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
Region VII (Cont.) 5. Land Application Of Wastewater And Aquaculture	a) Fate of viruses and pathogens in sewage sludge application		
6. Urban Runoff			a) Data on urban storm events
8. Small Wastewater Flows	a) Develop alternative control technologies		
Region VIII 1. Process Development	a) Design criteria for safe chlorination b) Decay/persistence rates of Cl_2 in streams		
3. Municipal Sludge Management	a) Land application practices for the western U.S. b) Pretreatment and disinfection guides for land application		
4. Plant Operations And Design	a) Design parameters for optimum clarifier performance b) Improved supernatant quality in anaerobic digestion c) Reliability of NH_3-N reduction in cold climates		
5. Land Application Of Wastewater And Aquaculture	a) Safe application practices for the western U.S. b) Pretreatment and disinfection guides for land application		

Table 3.6

SUMMARY OF RESEARCH NEEDS

Regional Offices

RESEARCH AREA	HIGH PRIORITY	MEDIUM PRIORITY	LOW PRIORITY
Region VIII (Cont.) 7. Energy	a) Evaluate potential for energy reduction, recovery and use		
9. Innovative And Alternative Technology	a) Demonstration of vertical tube reactor b) Demonstration of wet oxidation of sludge		
Region IX 1. Process Development	a) Assess conservation and reuse implementation measures		b) Use of salt water for toilets and groundwater protection
3. Municipal Sludge Management		a) Evaluate systems tradeoffs	
8. Small Wastewater Flows	a) Data on small scale treatment technology		
Region X 3. Municipal Sludge Management	a) Develop small scale sludge disposal processes		
7. Urban Runoff	a) Develop method for correcting I/I problems		

CHAPTER 4. RESEARCH PLANS

4.1 RESEARCH PLAN OVERVIEW

This chapter describes the research effort for each of ten areas of concern to municipal wastewater control:

- Process development
- Toxic pollutants control
- Municipal sludge management
- Plant operations and design
- Land application of wastewater and aquaculture
- Urban runoff
- Energy
- Small wastewater flows
- Innovative and alternative technology
- Health effects

Although some conceptual and technical overlap may exist, each of the above areas is treated as an individual research effort and is presented under a separate section herein. For each research area, a description is given of the objectives, recent accomplishments, the planned research outputs and the response of these research projects to Agency requirements. To facilitate the discussion of the responsiveness of the research projects, the Agency requirements described in the previous chapter are reiterated here as they pertain to each research area. Specific needs are listed in the "ORD Response to Agency

Research Requirements" section of each research area write-up. Following each need listed, the Program Office(s) and Region(s) requesting the work are noted with their stated priorities in parentheses ("H" for high priority, "M" for medium and "L" for low).

4.2 PROCESS DEVELOPMENT RESEARCH

4.2.1 Research Program Description and Objectives

Applied research activity in this area evaluates new technology for municipal liquid waste treatment using bench-scale, pilot-scale and full-scale approaches. Technology development is directed toward enhancing the ability of municipalities to meet discharge limitations in the most cost effective manner. These limitations may be concerned with oxygen demand, suspended solids, specific pollutants, harmful microbes or wastewater reuse.

Four national program areas are managed by EPA to conduct in-house and extramural studies as directed by the research and demonstration provisions of the Clean Water Act. These programs, which interface directly with the innovative and alternative technology program, are briefly described below.

Novel biological process program. Evaluates concepts and processes that depart significantly from conventional secondary treatment practice. Emphasis is placed on cost effectiveness achieved by:

- Decreased land requirements, decreased tankage and space savings
- Lower energy requirements
- Reduced sludge production
- Conservation of resources
- Alternative primary energy sources

Specific pollutant control program. Addresses the manipulation or combination of biological and/or chemical-physical processes to achieve defined effluent residuals. Recent examples include chelating agents, hazardous organics, phosphorus and nitrogenous compounds and priority pollutants as defined by the Natural Resources Defense Council Consent Decree (see Section 4.2).

Microbial control program. Evaluates approachés for disinfection of municipal effluents, survival of microorganisms in various sludges and genetic enhancement of microbial reactions. Current work has been devoted to demonstrating ultraviolet light and ozone for effluent disinfection, however, a major effort is planned to address wet weather flows and improved control of residual toxics by disinfectants.

Reuse program. The major goal of this program is the implementation of research and field evaluations that determine the feasibility and practicability of implementing water conservation alternatives. Particular emphasis will be on reusing municipal wastewater for both potable and nonpotable purposes.

These four programs furnish information for the research requirements of EPA Headquarters, Regional Offices, individual states, International Joint Commission, Consent Decree agreements, engineering design firms and municipal treatment facilities.

The Wastewater Process Development Group interfaces with the engineering and scientific communities, universities, MERL's Test and Evaluation Facility, cooperative grants program and Federally supported Centers of Excellence to guide new technology for environmental control.

4.2.2 Recent Research Accomplishments

Novel biological process program. Results from this program have been used at many locations. For example, 125 installations using high purity oxygen have resulted from the program's developmental work on this technology. Low cost lagoon treatment for small municipalities has been evaluated and techniques for upgrading effluent quality have been documented and put into practice. Studies on attached growth secondary processes, such as rotating biological discs and the activated biofilter, have provided key design information for these cost-effective processes. Work is now in progress to reduce the energy demand associated with secondary treatment by evaluating more efficient aeration devices.

The publications listed below describe the results of work conducted in the novel biological processes area.

- "Upgrading Primary Tanks with Rotating Biological Contactors". EPA 600/2-80-003. A novel application for converting a primary treatment plant into a secondary treatment facility, March 1980.
- "Field Study of Nutrient Control in a Multicell Lagoon," EPA 600/2-80-155. Developed a reliable technique for reducing phosphors from lagoon effluents, August 1980.
- "First National Symposium/Workshop on Rotating Biological Contactor Technology," Volumes I & II. Proceedings of the RBC Symposium provide the latest state-of-the-art on RBC technology, February 1980.
- "Fine Solids Removal Followed by Combined Chemical-Trickling Filter Treatment," EPA 600/2-80-099. A comparison of granular media filters and short detention settling ponds for upgrading alum coagulated trickling filter effluent, July 1980.
- "Converting Rock Trickling Filters to Plastic Media," EPA 600/2-80-120. Successful conversion and loading expansion of three existing rock trickling filters to world's largest plastic media trickling filters, August 1980.
- "A study of Nitrate Respiration in the Activated Sludge Process," EPA 600/2-80-154. A novel modification of the activated sludge process to remove organic carbon, nitrogen, and phosphorus in a single-sludge application, August 1980.
- "Wastewater Stabilization Lagoon-Intermittent Sand Filter Systems," EPA 600/2-80-032. Operating results of three full-scale lagoon-intermittent sand filter installations in three different climates, March 1980.
- "Performance Evaluation of the Aerated Lagoon System at North Gulfport, Mississippi," EPA 600/80-006. Comprehensive evaluation of a two-cell lagoon equipped with mechanical surface aerators, March 1980.
- "Performance Evaluation of Existing Aeration Lagoon System at Consolidated Koshkonong Sanitary District, Edgerton, Wisconsin," EPA 600/2-79-182. Comprehensive evaluation of a three-cell lagoon equiped with submerged hinde tubing diffusers, December 1979.
- "An Evaluation of Submerged Aeration Equipment." A summary of EPA Contract 14-12-150 on clean water test studies presented at 53rd Annual Water Pollution Control Federation Conference, October 1980.
- "Status of Deep Shaft Wastewater Treatment Technology in North America." A status report on deep shaft research and development efforts in North America presented to Seventh United States/Japan conference on Sewage Treatment Technology, Tokyo, Japan, May 1980.

The following reports have also been completed and are ready to be printed:

- "Feasibility Study of Open Tank Oxygen-Activated Sludge Wastewater Treatment." Pilot plant precursor study of commercialized FMC open tank oxygen system. December 1980.
- "Simplified Injection of Oxygen Gas into an Activated Sludge Process." Evaluation of inflated dome covered pure oxygen activated sludge process using existing air diffusion equipment. December 1980.
- "Parallel Evaluation of Air- and Oxygen-Activated Sludge." Comprehensive pilot-scale comparison of a Unox covered oxygen system and a submerged turbine air system. December 1980.
- "Survey and Evaluation of Fine Bubble Dome Diffuser Aeration Equipment." Two-continent survey of 19 dome diffuser activated sludge plants summarizing field oxygen transfer efficiency, power consumption and O&M requirements. December 1980.

Specific pollutant control program. About one thousand facilities are using technology developed in this program to meet water quality standards set for posphorus or nitrogen. The fate of hazardous organics, such as benzidine, in biological processes has been determined and all the Consent Decree organics have been evaluated for biodegradability. Organic substitutes for phosphate in detergent formulations, such as carboxymethyltartronate and nitrilotriacetic acid, have been studied in aerobic and anaerobic processes. Results from this program allow Regulatory and Program Offices to make decisions on the ability of municipal facilities to control defined pollutants and consequent costs associated with this control technology. Recent outputs from this program include the following:

- Phosphorus Removal in Lower Great Lakes Municipal Treatment Plants." A survey and documentation of phosphorus removal efficiency of municipal facilities discharging to Lake Erie and Lake Ontario, August 1980.
- "International Seminar on Control of Nutrients in Municipal Wastewater Effluents." A worldwide review of the state-of-the-art for controlling nitrogen and phosphorus, September 1980.
- "Proceedings of the Workshop on Decentralized Systems for Management of Water, Solid and Liquid Wastes." A workshop investigation of the future utility of periodic treatment processes for municipal and industrial wastes, June 1980.

- "New Secondary Treatment Processes for the 1980's." A presentation for the 54th Annual Conference of the Ohio Water Pollution Control Association, describing new approaches to municipal wastewater treatment, June 1980.
- "Wastewater Nitrification: Alternate Systems and Experiences." A presentation for the 44th Annual Conference of the Indiana Water Pollution Control Association, describing the many options for achieving nitrification and denitrification, November 1980.
- "Developments in Hazardous Wastes: Biodegradation of Priority Pollutants." Five reports presented at the 74th Annual AICHE Conference, dealing with laboratory, full-scale and consultant activities for controlling residuals of hazardous compounds, November 1980.
- "Steroid Hormones as Water Pollutants." Studies on the persistence of natural urinary and synthetic ovulation-inhibiting hormones in wastewater and effluents, August 1980.
- "Biodegradability Studies with Organic Priority Pollutants." April 1980.

Microbial control program. Since chlorine and its associated side-products have been shown to have negative environmental effects, work in this area has been concentrated on evaluating alternative disinfectants for municipal effluents. Demonstration of optimized chlorination procedures and subsequent dechlorination has shown that aquatic toxicity can be eliminated. A full-scale study of ultraviolet light disinfection has revealed this technique to be efficient and cost effective. Several demonstrations of ozone disinfection show this technology to be efficient, but more costly than either dechlorination or ultraviolet light. Both ozone and ultraviolet light technology are being designated in Step 1 facility plans. Ultraviolet light disinfection has been a major innovative technology approved for I&A funding in 14 wastewater treatment facilities. A number of reports has resulted from this work. They are listed below:

- "Proceedings of Wastewater Disinfection Alternatives - State-of-the-Art Workshop" - WPCF Disinfection Committee Pre-Conference Workshop, 1979 WPCF Conference. Five papers were presented:
  - Venosa, A.D., and E.J. Opatken. "Ozone Disinfection: State-of-the-Art."
  - Hubly, D.W., "Evaluation of Risks, Energy Costs, and Associated Economic Factors of Wastewater Disinfection Alternatives."
  - Rakness, K.L., B.A. Hegg, L.M. Boehme, and B.B. Fairchild. "Case History: Ozone Disinfection of Wastewater with an Air/Ozone system."
  - Roberts, P.V. "Chlorine Dioxide: State-of-the-Art."

  - Scheible, O.K., and C.D. Bassell. "Ultraviolet Disinfection of a Secondary Wastewater Teatment Plant Effluent."

- "Disinfection of filtered and Unfiltered Secondary Effluent in Two Ozone Contactores" - Article submitted to Peer Review Journal, Environment International, November 1980.
- "Physical Chemistry of Virus Adsorption and Degradation on Inorganic Surfaces" - EPA 600/2-80-136, August 1980.
- "Design Optimization of the Chlorination Process, Volume II: Comparison of Acute Toxicity of Chlorinated Effluents from Optimized and Existing Facilities" EPA 700/2-80-133, August 1980.
- "Studies of Methanogenic Bacteria in Sludge." EPA 600/2-80-093. August 1980.

Reuse program. Under this program, guidelines have been developed to assist water managers in deciding the feasibility of wastewater reuse. A study has been completed that measures, for the first time, the direct effects of indoor water conservation on wastewater collection and treatment systems with regard to positive and negative impacts. Technical and financial assistance was provided to Denver, Colorado, for the construction of a 3,785 m^3 per day reuse demonstration facility which should advance the technology needed for production of potable product water. Reclaimed wastewater is also being used for groundwater recharge in southern California.

4.2.3 Current Research Plan

The project milestones (Table 4.1) show the individual outputs planned for the four programs that comprise process development.

4.2.4 ORD Response to Agency Research Requirements

Headquarters operating programs and EPA Regional Offices have identified areas of research needs in process development. Common needs concern energy conservation, impacts of combined sewer overflow (CSO), alternative disinfectants and modification of process to more effectively control specific pollutants such as toxics. Regional interest in reuse was limited to conservation practices. All needs expressed in the process development area are listed below:

a. Finalize disinfection manual - OWPO(H), Region V(H), Region VII(H), Region VIII (H)
b. Technology transfer of alternative disinfection information - OWPO(M)
c. Improved toxics and pathogen analytical techniques - OWPO(M)
d. Removal capabilities and effects associated with new processes - OWRS(H)
e. Field investigation of "phostrip" installations - Region I(H)
f. High energy electron irradiation of wastewater - RegionI(H)
g. Minimize impact on biota of reuse for cooling - Region II(L)
h. Develop wastewater disinfection guidelines - Region III(H)
i. Methods to correct nitrate accumulation in groundwaters - Region IV(H)
j. Evaluate Biodisc and ABF processes - Region VII(H)
k. Decay/persistence rates of Cl2 in streams - Region VIII(H)
l. Assess conservation and reuse implementation measures - Region IX(H)
m. Use of salt water for toilets and groundwater protection - Region IX(L)

Novel biological processes. Research for energy reduction for secondary treatment is being conducted by the program in three areas. More energy efficient aeration devices are being evaluated. Processes that operate at high organic and volumetric loadings are under investigation. Low energy anaerobic treatment of mainstream wastewater is in the feasibility stage. The highly loaded systems are also coincidentally being monitored for ability to handle peak loadings caused by combined sewer overflows (CSO).

This type of novel process development must be supported by Federal funding, since the main thrust is frontier development, and consultants, municipalities and manufacturers are hesitant to try non-proven technology. A broad range of options is being investigated, such as vertical shafts, combined reactor and clarifier, fluidized beds, batch reactors and downflow attached growth processes. The potential pay-off from this program in terms of national savings of energy and reduction of special requirements warrants high research investment.

Specific pollutant control. Control of specific pollutants usually leads to process development that is classified as advanced secondary treatment (AST) or advanced waste treatment (AWT). To date, research results indicate that control of specific organics to low residuals requires that POTWs operate with long sludge retention times and low effluent suspended solids levels. Conventional technology will not provide low residuals of toxics. In view of the AST and AWT funding policy, toxics control investigations will be limited to low cost operational modifications to achieve better toxics control in a practical and feasible manner.

Microbial control program. In response to Headquarters directives and Regional needs, the program is shifting research objectives and resources away from effluent disinfection objectives to microbial hazards in sludges and CSO. A great deal of effort will be made to transfer presently accumulated data on alternative disinfectants by preparation of design manuals and seminars. Work on sludge pathogens will be coordinated with the municipal sludge management program.

The work on CSO will be coordinated with the CSO group, which will make recommendations for requirements and project selection for demonstrating pathogen control.

The RCRA regulations have a substantial impact on waste treatment facilities that do not employ either incineration or anaerobic digestion. The microbial control program will re-program funds to study pathogen levels in extended aeration facilities, aerobic digesters and oxidation ditches. Whether these treatments sufficiently reduce pathogens to allow land disposal of sludges must be demonstrated.

Reuse program. Due to the health effects issues in this program, immediate work will focus on non-potable reuse and water conservation impacts.

To continue the three areas of study in the novel biological process program, an infusion of funds will be required. If the needs expressed by Region VII for rotating biological discs design data, and the needs of Region IV and VIII for clarifier design data are to be met, additional resources will be required. To encompass the need of Region I for biological phosphorus control, Region IV for preventing nitrate accumulation in groundwater, the needs of several Regions to know the fate and effects of toxics in POTWs* and the Region VIII desire for cold temperature nitrification data*, additional funding for specific pollutant control would be necessary.

Major reprogramming of funds will be necessary for technology transfer of alternative disinfectant data, to publish a disinfection manual and to address the needs of Regions I, III, V, VII, and VIII regarding disinfection, sludge pathogens and CSO pathogen studies.

Specific needs which are not addressed by the current program are f, g, h, k, i and m in the above list.

No major funding in the reuse area is planned for the near future.

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*Needs listed under Plant Operation and Design

Table 4.1

LEGEND:

▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

SCHEDULE OF R&D OUTPUTS

Process Development

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
NEW BIOLOGICAL PROCESSES																																						
1. Upgrade lagoons by low cost methods																																						
a. Slow rock and intermediate sand filters			▲																																			
b. Lagoon design manual									△	—	—	—	△																									
2. Efficient O_2 transfer in biological systems and new process development																																						
a. European survey of fine bubble diffusers								▲																														
b. ABF evaluation							△	—	△																													
c. Clean water evaluation submerged aeration equipment									△	—	—	△																										
d. Standard O_2 transfer test recommendations								△	—	△																												
e. Deep shaft evaluation															△																							
f. Reactor clarifier																				△																		
g. Dirty water testing high efficiency aeration devices																			△																			
h. Optimization of fine bubble aeration power economy - England																						△																
i. Anaerobic retrofit to existing* aeration tank																					△																	
j. Aerated biological filter (ODA)* evaluation																							△															
k. Verify O_2 transfer standards																					△																	
3. Rotating Biological Contactors																																						
a. Survey to develop interim RBC design guidelines				▲																																		
b. National symposium RBC							▲																															

✱ Projects that could be completed with funding above FY81 level.

Table 4.1

SCHEDULE OF R&D OUTPUTS
Process Development

LEGEND:
- ▲ Completed Project Outputs
- △ Proposed Project Outputs
- — Estimated Project Period

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
c. Field study to develop RBC design criteria																			△																			
d. RBC reaction kinetics (in-house)															△																							
4. Evaluation of batch reactors and fluidized bed reactors																																						
a. Full-scale sequencing batch reactors								△	—	—	—	—	—	△																								
b. Full-scale fluidized bed reactors for carbon removal																													△									
BIODEGRADATION AND SPECIFIC POLLUTANT REMOVAL																																						
5. Biodegradation																																						
a. Interim report biodegradation PP (Specific comp) protocols			▲																																			
b. Static biodegradation of PP							▲																															
c. Continuous flow biodegradation of PP											△																											
6. Nutrient removal																																						
a. Analysis of P removal in Great Lakes			▲																																			
b. International nutrient control seminar						▲																																
c. Design manual (N) and (P)*																									△													
d. Feasibility of low cost, low residual* P control (Region V)																			△																			
e. Evaluate Bardenpho*																							△															
MICROBIOLOGICAL CONTROL																																						
7. Chlorination																																						
a. Report chlorination and dechlorination optimization	▲																																					

* Projects that could be completed with funding above FY81 level.

LEGEND:

- ▲ Completed Project Outputs
- △ Proposed Project Outputs
- — Estimated Project Period

Table 4.1

SCHEDULE OF R&D OUTPUTS

Process Development

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
8. Ozone																																						
a. Ozone for stringent disinfectant requirement							▲																															
b. Ozone measurement								△	—	—	—	—	—	△																								
c. Ozone disinfection and trace organic control (in-house)																															△							
9. Ultraviolet light																																						
a. Full-scale UV light demonstration							▲																															
b. Evaluate UV for disinfectant and trace organic removal (in-house)																															△							
c. UV light dosage control																							△															
d. UV disinfection of 30/30 and CSO effluents																					△																	
10. Chlorine dioxide (ClO_2)																																						
a. Chlorine vs chlorine dioxide comparison				△	—	—	△																															
11. Disinfection of antibiotic-resistant organisms																																						
a. Occurrence of antibiotic-resistant coliforms													△																									
b. Effectiveness of disinfection on after growth																									△													
c. Genetic engineering for enhanced* phosphorus removal																										△												
12. Disinfection SOA technology transfer																																						
a. Risk-benefit-cost of alternative disinfectants												△																										
b. Disinfection evaluation manual*																										△												

* Projects that could be completed with funding above FY81 level.

Table 4.1

SCHEDULE OF R&D OUTPUTS

Process Development

LEGEND:

▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
1) California Manual on Chlorine									△																													
c. Disinfection seminar-HERL-MERL-CERI															△																							
REUSE AND WATER CONSERVATION																																						
13. Denver potable water reuse demonstration																																						
a. Completed design							△	▲																														
b. Construction complete																					△																	
c. Trial operation completed																											△											
14. Potable reuse demonstration at existing sites																																						
a. Orange County WF 21*												△																										
b. Santa Clara/NASA*													△																									
c. Long Island*													△																									
15. Water conservation practices																																						
a. California experience				△	—	▲																																
b. East and midwest experience*																			△	—	—	—	△															
c. Guidelines*																									△	—	—	—	△									
16. Non-potable reuse criteria and systems evaluations																																						
a. Reuse guidelines				△	—	—	▲																															
b. System evaluation reports*																									△													
c. Water quality criteria report*																															△							

✱ Projects that could be completed with funding above FY81 level.

4.3 TOXIC POLLUTANTS CONTROL RESEARCH

4.3.1 Research Program Description and Objectives

While the Agency has had a long-standing concern about nonconventional pollutants in POTW treatment, research was limited to selected metals and occasional organic pollutants. Following the Natural Resources Defense Council (NRDC) Consent Decree with EPA in 1979, attention, and most importantly, resources were focused on specific toxic compounds. Based on the Consent Decree, a list of 65 compounds and classes of compounds was established which subsequently evolved into a list of 129 individual compounds which have become known as the priority pollutants. Three organic compounds have since been removed from the list. The Decree directed EPA to establish effluent guidelines for the discharge of toxic substances employing Best Available Technology Economically Achievable (BATEA) for 21 primary industries by December 31, 1979. This date has since been extended to 1987. It is estimated that 87,000 industrial plants, classified under the 21 primary industries, discharge their wastewaters directly to publicly owned treatment works (POTW). The Clean Water Act of 1977 further requires that industry pretreat their wastewaters to meet effluent standards established by the Effluent Guidelines Division. Major considerations in these standards are the ability of the POTW to treat these compounds with minimum concentrations in the effluents and without adverse effects on the treatment processes and that sludges shall not be contaminated to levels which limit their disposal on land. Section 307 further allows consideration of credits for the removal of toxics at POTWs in the setting of pretreatment standards for industrial discharges to POTWs.

Some toxic chemicals are unique in that they are highly persistent (nondegradable) under natural conditions and are highly mobile (bioaccumulative) in the environment. Thus, air, land and water (surface and groundwater) and most biological tissues can be contaminated with detectable concentrations. Toxic chemicals pose various degrees of threat to human health and aquatic life. These degrees range from the acutely toxic, where exposures to high concentrations over a short period of time can result in immediate effects (i.e., fish kills or treatment plant upsets), to the chronically toxic, where long-term exposures to low concentrations can result in delayed effects. As a consequence of these toxic characteristics and the widespread nature of these chemicals, virtually all segments of EPA have become involved in some aspect of toxic pollutants control.

The Wastewater Research Division, through the toxic pollutants control program, has been assigned the responsibility to conduct research on toxic compounds in POTWs. Broadly, the aims of the program are to eatablish the extent of the problem in POTWs and to develop treatment options and technology to control the discharge of toxic substances into the environment.

Specifically the objectives are:

- Development of data bases on priority pollutants in terms of sources contributing to POTWs, occurrence and concentration in POTWs influents, effluents and sludges, and removals obtainable by unit processes.
- Assessment of treatability and removability of priority pollutants by a variety of conventional and AWT processes. Processes receiving initial attention are carbon adsorption (sorption in general), biodegradability and desorption by "stripping."
- Development of treatment processes which enhance the removal of priority pollutants from wastewater. The degree of research effort on treatment processes will be tailored to the problem as revealed in the first objective.
- The final objective is data-base development and area-wide analysis of toxics control by various modeling approaches.

4.3.2 Recent Research Accomplishments

In spite of limited resources, it seemed prudent to address all of the above objectives concurrently rather than sequentially, although major emphasis has been placed upon assembling a data base on the occurrence of priority pollutants in POTW influents and evaluating the removals across treatment processes. Data have been obtained on effluent and sludge concentrations. The data base assembly included both the organic compounds and metals on the priority pollutant list. With the completion of ongoing studies, a sufficient data base will have been accumulated to define, at least in a preliminary way, the extent of the problem of priority pollutants in POTWs. Preliminary findings (EPA 440/1-80-301 and other final reports in preparation) show that, in terms of sources, industry is the major contributor of priority pollutants to the POTW. Some 70-90 of the priority pollutants have been identified in one or more plant influents (Arthur D. Little, Inc., 1979). With the exception of certain metals, the concentrations in the plant influents range from a few hundred parts per billion to barely detectable. Certain classes of compounds, for example, the chlorinated alkanes, phthalates, substituted aromatics and metals tend to be found more consistently and at generally higher concentrations.

Removal of toxics by secondary treatment has been shown to be highly variable. However, 50% of the plants examined achieved 70-85% removal of organics from the liquid flow (Petrasek et al., 1980, WPCF 53rd Conference). While some of this removal was achieved by volatilization and biodegradation, a significant proportion of certain compounds was found in the sludge. In fact, analysis of the sludge sometimes revealed compounds that were below detectability in the influent.

Using available data, a model has been developed (TOXFLO) which can characterize loadings of toxic compounds to a sewerage system and the ability of a POTW and a given pretreatment technology to remove them.

Concurrent with the data-base accumulation, studies were undertaken to assess the treatability and removability of all of the priority pollutants. Many of the preliminary studies on carbon adsorption, biodegradability and volatility have been completed (final reports in review). The more complex problem of evaluating removal by treatment processes has been started, but work will need to be continued. The indications are that most compounds can be removed from aqueous solution via either biodegradability and/or by carbon adsorption.

A study of the sewerage works of Kokomo, Indiana, was performed to determine the concentrations and sources of trace metals and cyanide in the local wastewater and sludge (report in press). The results showed that the activated sludge treatment removes 80-98% of the metals, except nickel, from the aqueous into the sludge phase. In another study, the effect of hot acid treatment on removing toxic compounds from sludge was examined (EPA 600/2-80-96).

Carbon adsorption and volatility of toxic compounds have also been examined. Work on adsorption isotherms for organic priority pollutants was recently published (EPA 600/8-80-023). The volatility of 40 organic priority pollutants was examined by determining Henry's Law constants for these compounds and by measuring airborne emissions from aeration basins. Several compounds have been identified which are particularly troublesome in terms of emissions to the atmosphere.

At this point, it is important to state again that toxic compounds permeate the entire environment and thus become major objectives of research programs of practically all segments of the Agency. The program described above for POTWs represents only a fragment of the total effort and resources devoted to the control of toxic pollutants. Strategies for handling toxics in other media and for toxicity to man and other life forms will be addressed by the research programs responsible for these areas. All of the programs for toxics should be considered as complementing each other.

4.3.3 Current Research Plan

Current and planned projects fall under four general categories: toxics data base; toxics removal processes; toxics treatability; and new initiatives. These projects are listed in Table 4.2 along with a schedule of major milestones.

4.3.4 ORD Response to Agency Research Requirements

In the area of toxic pollutants control, 28 research requirements have been identified by the Program and Regional Offices. Of this total, about one-third overlap. Most of these research needs are addressed by recently completed or new research activities. The completed work was discussed previously and ongoing or planned research is described below.

Data base on occurrence and removal of toxics by process and treatment systems. Three Program Offices and one Regional Office have requested the following information in this area:

a. Determine sources of priority pollutants - OWRS(H), OWE(H), Region V(H)
b. Compare secondary treatment to source control - OWRS(H)
c. Formation of toxics within POTW processes -OWRS(H), OPTS(M)
d. Evaluation of BMPs - OWE(H), OWRS(M)
e. Compare point vs. nonpoint sources of toxics - OWRS(H)
f. Data for toxics material balances -OWRS(H), OPTS(H)
g. Analyze institutional impediments to pretreatment - OWRS(H)

Completion of the 25-city survey, the Kokomo POTW study and the University of Tennessee data-base evaluation will provide information for many of the above needs. Work is continuing on recording the results of these surveys in a computerized storage and retrieval system. Projects that will contribute data to the system are: 25-city survey by MERL; 40-city survey by the Effluent Guidelines Division (EGD); 4-city collection system survey by MDSD; and special treatability studies by MERL's T&E facility. Information on toxics occurrence from non-point sources will be provided by studies conducted by the NURP program.

Certain areas of the data base need to be expanded, such as emissions, and most importantly, an assessment of toxic compounds not considered as priority pollutants. The latter will be addressed by analyzing the computer tapes obtained from the 25-city survey. Other approaches, such as analysis of extracts using alternative analytical methods, may need to be taken. From the list above, needs that will not be specifically addressed by current and planned research include b, c and d.

Treatability of toxics by unit processes. Two Program Offices have requested research in this area:

a. Toxics treatability studies - OWPO(H), OWRS(M)
b. Inhibition studies on POTWs - OWRS(H)

c. Technologies for toxics removal/destruction; in-plant processes; treatability studies - OWPO(H,M), OWRS(M)

d. Publish sludge toxics fixation and extraction information - OWPO(M)

e. Data for toxics material balances - OWRS(H), OPTS(H)

Several projects are under way to address these needs. A major effort on assessing the removal capabilities of unit processes is being conducted on a pilot plant scale at the Test and Evaluation Facility. The studies include emissions due to volatility and removal by unit processes of non-volatile compounds. Mass balances, mentioned in several needs, will be attempted across the treatment processes. Experimentally, mass balances, while very desirable, are extremely difficult to obtain for a variety of reasons: the very low concentrations being handled; the inherent substantial analytical uncertainty; errors in flow measurement; and loss of compound by biodegradability. An important additional area of work is to determine the partitioning of toxic compounds between the aqueous solution and sludge. Because of the importance of the latter, a study on sludge partition coefficients of toxics is under way in-house. The biodegradability of priority pollutants is also being studied.

A long-term fundamental study has been ongoing to evaluate the mechanisms and the effectiveness of adding powdered activated carbon to conventional activated sludge systems. While the concept is not new, the ability of the process to remove specific toxic organics has not previously been studied. The current approach is to investigate the enhancement of removals by adding powdered activated carbon to aeration basins. The waste activated sludge containing up to 50% of exhausted carbon is processed by wet-air oxidation which simultaneously incinerates the biomass and regenerates the carbon for recycle to the system. Thus, in a single operation the disposal problems associated with waste activated sludge and the destruction of absorbed organics are eliminated. The process also achieves nitrification. Both a laboratory-scale study and a field evaluation are ongoing or planned. Activated carbon is also a useful approach for additional removal of organics from secondary effluents. A process involving the addition of ozone to the carbon contactors is being conducted at pilot-plant scale. A longer term goal of this type of research is the development of a sufficient understanding of how organic compounds behave with respect to the above processes. Structure/activity analysis or mathematical modeling will become useful in predicting the behavior of untested compounds.

Several hundred POTWs currently add chemicals - lime, alum or iron salts - to the biological process to remove phosphorus. Geographically, the plants are predominantly located near the Great Lakes and other large lakes. These locations also coincide with high population and industrial densities. While the phosphorus removal capability of these additives has been well documented in laboratory and full-scale operations, virtually no information is available on the enhanced removal of metals. Some 13 metals are on the list of priority pollutants. Typically, biological plants are capable of removing metals from the influent, but the removals are erratic, unpredictable and, in some instances, incapable of meeting the stringent water quality standards. A study is planned to evaluate the removal of metals when phosphorus reducing chemicals are added to biological aeration systems. The known ability of chemicals to precipitate and adsorb metals suggests that these plants, in addition to removing phosphorus, are also obtaining enhanced removal of metals. The effect of increasing the metals content of the chemical sludges remains to be considered.

Several studies continue to address toxics stripping from aeration basins. Henry's Law constants continue to be studied and an effort is being made to model the mechanisms of organics emissions from unit processes.

One need that has been expressed, and is being addressed, is to determine the inhibition of biological processes by toxic compounds. Much literature is available on the concentrations of metals that are toxic to aerobic processes. More recently, the Test and Evaluation Facility conducted an in-depth study of cadmium and concluded that inhibition (monitored by COD in the effluent) did not occur until the influent cadmium concentration reached 4.1 mg/l. A report entitled "Inhibition of the Activated Sludge Process by Cadmium" and authored by A.C. Petrasek will be issued shortly. Work on other metals is being considered. Plant survey results suggest that the concentration of organics currently being observed in plant influents is too low to likely cause problems with treatment. One aspect of this which should be investigated is the sensitivity of anaerobic processes to interference by organics.

Measurement, fate and effects. Four Program Offices and Region V have stated needs in the area of measuring toxic compounds and tracing them after their discharge to the environment.

a. Fate and effect of toxics in CSOs and recycled wastewaters and sludge - OWPO(H)
b. Effect of toxics on stream quality and uses: aquatic life, sediment buildup, predictive models - OWPO(H), OWRS(H), Region V(H)
c. BAT impact on receiving waters - OWRS(M)
d. Monitoring effluents and receiving waters below POTW outfalls - OPTS(H), OWE(H)
e. Alternatives to chemical monitoring - OWE(H)
f. Sampling and testing protocols - OWRS(M)
g. Develop and test indicators and measurement methods - OWRS(H,M), OWE(H)

Less expensive analytical techniques and the development of indicator parameters for toxic compounds have been widely requested. Present analytical methods for priority pollutants are extremely burdensome in that sophisticated and expensive instrumentation is required, and highly skilled analysts are necessary. In addition, the entire procedure is slow. The consensus is that few industrial or POTW plants could afford to have the expertise to monitor their treatment operations. There is, therefore, a clear need for a less expensive and less demanding parameter or series of tests which would indicate the presence of priority pollutants. While the need is obvious, the discovery and development of an indicator parameter(s) is an extremely difficult goal to achieve. The great diversity of chemical species and the large differences in degrees of toxicities contribute to the difficulty of the indicator approach. The obvious need and the advantages to be gained from this approach demand that serious attempts be made to accomplish this difficult goal. In addition to efforts by others, this program is also pursuing the objective by the RFP route to solicit the best ideas available in the country.

In addition to the sampling and analytical problems, several other needs (a, b, c and e in the above list) have not been addressed. This does not mean that these needs are not important, but resource limitations have required a priority system in which some work must be deferred to later years.

To conclude, there would seem to be a need for a compendium and assessment document which brings together, into one source, all of the research information on toxic compounds in POTWs that has been accumulated by that time. At present, the information is dispersed in many reports and is too voluminous to be useful to the practitioner in the field. An example of this type of compendium is the five-volume Treatability Manual which was produced by the Treatability Coordination Committee.

Table 4.2

SCHEDULE OF R&D OUTPUTS

Toxic Pollutants Control

LEGEND:
▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
1. Toxics Data Base: Generation Management, and Indicator Development																																						
a. Data generation by 25-city survey				△	—	—	—	—	△																													
b. Computerized cost optimization model for urban toxic control strategies							△	—	—	—	—	—	△							△						△												
c. Interim reports on toxics at POTWs (survey), analysis of influents, effluents, and sludges				▲		▲																																
d. Compendium and assessment reports						△		△												△						△												
e. Test of alternative indicator approaches				▲																		△																
f. Risk assessment model for meeting regulations under various control strategies										▲												△																
2. Toxics Removal Process Evaluation and Developments.																																						
a. T&E Facility toxics works								▲					△			△				△																		
b. Toxics stripping from aeration basin									▲						△					△																		
c. Improved analytical techniques for organics extraction from wastewater and sludges						▲																																
d. Cadmium and metals removal by lime									▲																													
e. Biological Modification studies																△							△															
f. Improved clean-up techniques for increased sensitivity & precision					▲																																	
g. Biological treatment modification by adding adsorbents												*				△							△															
h. Evaluation of ozone/carbon absorption toxics removal																			△																			

* Projects that could be completed with funding above FY81 level.

Table 4.2

SCHEDULE OF R&D OUTPUTS

Toxic Pollutants Control

LEGEND:

▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
3. Toxics Treatability																																						
a. Progress reports on biodegradation literature survey										▲																												
b. Carbon adsorption structure-activity analysis organics stripping model																△																						
c. Biodegradability of priority pollutants				▲																																		
4. New Initiatives																																						
a. Treatability of non-priority pollutants																△						△																
b. Treatability under anaerobic conditions																△						△																
c. Design Manuals for Toxics																△						△																
d. Assessment of cost and energy for toxics removal																		△										△										

✱ Projects that could be completed with funding above FY81 level.

4.4 MUNICIPAL SLUDGE MANAGEMENT RESEARCH

4.4.1 Research Program Description and Objectives

Since its inception, the sludge management program has addressed the development and demonstration of processes for the treatment, conversion, and use of sewage sludge, and the scientific, engineering, and environmental aspects of sludge management.

In the early years of the program, emphasis was on technology development and demonstration. Environmental concerns in recent years have required increased concentration on scientific objectives related to toxic metals and pathogens in sludge. Currently, nearly half of the program resources address these objectives. The program has moved to increase the effort in establishing relationships among levels of toxicants in sludge, effects on soil, uptake in plants and effects of processing on pathogens, and effects on consumers of crops; to determine levels of pathogens in sludge, effects of processing on pathogens, and effects on exposed populations; and to design and evaluate management systems to minimize adverse effects. The redirection of effort has produced information that has provided the scientific background for regulations issued under the requirements of the Resource Conservation and Recovery Act and the Clean Water Act for control of sludge application to the land.

The escalating cost of energy has had an exceptionally heavy impact on sludge management practices. Anaerobic digestion, which was steadily losing ground to aerobic digestion, is now a highly favored process. Incineration has remained viable only because new dewatering devices produce higher solids cake. When such upgrading has proved impractical, many municipalities have turned to lime stabilization. Our program has anticipated the needs imposed by high cost energy and has concentrated on technology and processing that minimize power and fuel costs.

4.4.2 Recent Research Accomlishments

The sludge management program has made significant advances in technology both in process development and in resolving scientific issues. Some of the more significant advances are summarized below.

Lime stabilization. This process has advanced from bench- to full-scale. Pathogen reduction and stabilization effects have been verified, technology transfer has been completed and the process has been installed in several dozen treatment plants. A report entitled "Review of Techniques for Stabilization of Municipal Wastewater Sludges with Lime and Their Ultimate Disposal" (Camp, Dresser and McKee) is currently in press.

Composting. Cooperative research with USDA has advanced the static pile process from pilot- to full-scale, major scientific issues have been resolved, and adoption by communities has been extensive. The magnitude of the impact of the process requires a continuing development program. Within-vessel processes are being developed for situations, such as close proximity to residences where unconfined composting has some drawbacks. The USDA project resulted in the publication of a manual for composting sewage sludge by the Beltsville Aerated-Pile Method (EPA 600/8-9-80-022). Other reports on this topic have recently been completed. "Biostabilization of Wastewater Sludge Via Composting on a Barge" (Resource Conversion Systems, Inc.) and "A Survey of BAV Composting Plants in Germany" (Camp, Dresser and McKee) are in press, while "Evaluation of 'Within-Vessel' Sewage Sludge Composting Systems in Europe" was published in January 1980 (NTIS No. PB 80-180847).

Pathogen reduction. Awareness of potential hazards related to the presence of pathogens in sludge and the method of sludge disposal have led the program to scientific and development efforts that have established the pathogen reduction capabilities of conventional sludge stabilization processes. The technology has been defined for producing almost any level of pathogen reduction at increased but not prohibitive cost. The background of scientific information has been of great value in providing both direction and support to recent RCRA regulations pertaining to the land application of sludge. The partial and total disinfection processes provide process designers with the flexibility to meet requirements of virtually any disposal situation at reasonable cost. Recently completed reports on this subject include three Sandia Laboratory publications. Two deal with the irradiation of sewage sludge and dried sewage solids (SAND 80-7097 and SAND 79-2240), while the third addresses the risk to animal health from pathogens in municipal sludge (SAND 80-7088).

Heavy metal discharges from incineration. Investigations of sludge incineration quantify the losses of heavy metals from sludge incinerators, provide suggestions for reducing emission levels by operating controls and suggest new control technology for reducing emissions. One publication on this topic, entitled "Emissions of Heavy Metals from Sewage Sludge Incinerators" (H. Wall and J. Farrell) is now in press.

New thermal processes. Modifications of incineration (e.g., starved-air combustion) that allow control of hydrocarbon emissions from multiple hearth furnaces without the need for expensive afterburning have been developed. This avoids the need for large quantities of high-grade fuel. A recent accomplishment in this area is the presentation of a paper on thermal conversion of sludge in a multiple-hearth furnace, using a substoichiometric supply of oxygen. The paper was given at the 7th U.S.-Japan Conference on Sewage Treatment Technology (May 1980).

Use of sludge on farms. Demonstrations in Ohio have produced a successful model plan for use of sludge on private lands that can meet the needs of small cities. The plan requires that a measure of control be freely given by the communities to farmer advisory groups. The results of this work are presented in "Information Programs Affect Attitudes Toward Sewage Sludge Use in Agriculture" (EPA 600/2-80-103), published in July 1980. In addition, two videotapes of the Ohio Farm Bureau demonstration (for technical and non-technical audiences) have been prepared and made available through the CERI film library.

Sludge in land reclamation. The ability of sludge to reclaim soil disturbed by mining activities has been demonstrated successfully in Pennsylvania.

Results have been dramatic and have changed the whole climate of acceptability in Pennsylvania and adjoining states. Major cities, such as Philadelphia, have solved their sludge disposal problems by using sludge for rejuvenating strip-mined land. A recently completed report on this topic is "Revegetating Strip-Mined Land with Municipal Sewage Sludge" (Pennsylvania Department of Environmental Resources - in press).

Metals in sludge used in agriculture. A research program, studying the impacts of metals in sludge on crop uptake and soil fertility, has established conservatively safe limits for sludge utilization that protect both the food consumer and soil productivity. This research provided the scientific basis for recently issued RCRA regulations for the use of sludge on agricultural land. A report entitled "Effects of Sewage Sludge on the Cadmium and Zinc Content of Crops" (Council for Agricultural Science and Technology, Report No. 83) resulted from this work.

In addition, the following reports have been completed:

- Treatment
  - "Parallel Evaluation of Low Speed Scroll Centrifuges and Belt Filter Presses for Dewatering Municipal Sewage Sludges," LA County, in press.
  - "Removal and Recovery of Metals and Phosphates from Municipal Sewage Sludge," University of Waterloo, EPA 60/2-80-037, June 1980.
  - "Integrated Energy Systems and Monitoring Municipal Wastewater Treatment Plant, Wilton, Maine," Wright-Pierce, Interim Report, over 100 requests for copies mailed out.
  - "Chemical Primary sludge Thickening and Dewatering," Eimco, EPA 600/2-79-055, July 1979 (actually released in 1980).
  - "Sludge Dewatering and Drying in Sand Beds," University of Massachusetts, EPA 600/2-78-141, August 1978 (actually released in 1980).
  - "Evaluating of Hot-Acid Treatment for Municipal Sludge Conditioning," Walden Research, EPA 600/2-80-096, August 1980.
  - "Engineering Assessment of Vermicomposting Municipal Wastewater Sludges," Camp, Dresser and McKee, in press.
  - "Engineering Assessment of Hot-Acid Treatment of Municiplal Sludge for Heavy Metals Removal," Camp, Dresser, and McKee, in press.
  - Pilot Scale Anaerobic Filter Treatment of High Strength Heat Treatment Liquor," Hydroscience, in press.
  - "Pilot Scale Anaerobic Filter Treatment of High Strength Heat Treatment Liquor," Hydroscience, in press.
  - "Auto Heated Thermophilic Aerobic Digestion with Air Aeration," Cornell University, in press.

  - "Evaluation and Optimization of the Anaerobic Digestion of Municipal Sludges," Kenosha, Wisconsin, in press.
- Conversion
  - "Coincineration of Sewage Sludge with Coal or Wood Chips," Minneapolis-ST. Paul, in press.
- Utilization
  - "Wastewater Solids Utilization on Land Demonstration Project," Ocean County, New Jersey, EPA 600/2-80-090, August 1980.
  - "Soils Temperature and Sewage Sludge Effects on Plant and Soil Properties," USDA, SEA, in press.
  - "Effects of Sludge Irrigation on Three Pacific Northwest Forest Soils," METRO-SEATTLE, Seattle, EPA 600/2-80-002, March 1980.
  - "Production of Non-Food Chain Crops with Sewage Sludge," Peer Consultants, Inc., in press.
  - "Helminth and Heavy Metals Transmission from Anaerobically Digested Sewage Sludge," University of Illinois, in press.

4.4.3 Current Research Plan

The research plan is outlined in the milestone charts Tables 4.3a, 4.3b and 4.3c. Some changes in direction are indicated. Conversion technology, for example, is receiving more emphasis and a new program has been started in treatment to determine pathogen reduction in extended aeration, oxidation ditch and similar sludge treatments. Under utilization on land, a task has been introduced to form a farmer advisory service on sludge, to be operated through the Cooperative Extension Services (Federal and/or state). Initiatives are suggested in the following areas.

Conversion technology. Conversion processes require major funding if they are to be demonstrated adequately. Progress will be slow unless sufficient funds are infused to allow test and evaluation programs to be carried out for conversion processes constructed under other programs (e.g., Construction Grants Program) and to allow construction as well as evaluation of processes with outstanding potential. An initiative of $700,000 for three years would allow the initiation of two important conversion projects.

Land utilization. Negative outlooks on sludge utilization have been generated by real or proposed restrictions, such as proposed regulations for sludge give-away programs. Despite the climate of uncertainty, sludge utilization on land is growing, and there are remarkable success stories that are being overlooked. The success of low application rate use in Ohio (Ohio Farm Bureau) and reclamation in Pennsylvania shows that the restrictions may in fact have served a purpose--dubious practices are yielding to practices that unquestionably satisfy regulations and still produce substantial benefits. It will be a major shortcoming of the program if negative attitudes undermine the will to do exactly what should be done to find the best approaches and vigorously support them. Consequently, an initiative is suggested with another state to support a land reclamation program patterned after efforts in Pennsylvania. Such a program would cost $190,000/yr for three years.

4.4.4 ORD Response to Agency Rresearch Requirements

Activities in sludge management are divided into three generic areas: treatment of sludge to prepare it for land use, disposal or conversion to another form; conversion of sludge to a form not recognized as sludge (e.g., composting, incineration); and utilization and disposal of sludge (utilization is primarily for soil-amending purposes). In each area, processes and procedures are developed and demonstrated to provide scientific and engineering information of importance to the Agency.

Treatment. Needs expressed by the Program and Regional Offices under this subheading are listed below:

a. Presence and quantity of toxics in sludge - OPTS(M)
b. Evaluate POTW processes for pathogen reduction - OSW(M)
c. Regrowth prevention for pathogens in sludge - OSW(H)
d. Good management practices for contaminated sludges - OWPO(L)
e. Improved processing information - OWPO(L), OWRS(H)
f. Further information of by-product formation by Purifax process - Region I(H)
g. High-energy electron irradiation of sludge - Region I(H)
h. Improved methods of sludge processing and disposal for small POTWs - Region I(H)
i. Develop energy sources from sludge - Region I(M)

The major technological subdivisions under treatment are dewatering and conditioning, disinfection and stabilization, energy technology, and toxicants removal.

- Dewatering and conditioning. An important influence on progress in this area, particularly in recent years, has been aggressive competition among manufacturers of equipment and among producers of polymeric conditioning agents. Encouragement of development of new devices and conditioning agents is not ordinarily needed rather, unbiased assessment of the best areas for utilization, comparative economics, design procedures, and performance histories are appropriate. Recent efforts have been dissemination of information, such as the process design manual, "Sludge Treatment and Disposal," and a strategy manual for sludge dewatering, which is in preparation. This latter effort responds to a direct need of the Office of Water Program Operations.

  It is proposed to regularly prepare reviews of rapidly advancing areas of treatment technology and to disseminate this information to EPA, state staffs and practicing engineers.

- Disinfection and stabilization. The advances needed in this area are for basic information on effects and new processes. For the most part, the private sector has shown little activity in this area, so initiative has had to come from EPA's program. Primary emphasis has been on adequately reducing putrefaction potential of sludge while at the same time achieving suitable pathogen destruction. Considerable effort has gone into establishing pathogen reduction levels of anaerobic digestion and into newer processes that produce greater reductions. This information has provided important support for RCRA regulations.

  The requirement of RCRA regulations that all sludge be treated at least by a process that "significantly reduces pathogens" before it can be applied to land makes it appear likely that sludges from processes such as aerobic digestion, extended aeration and oxidation ditches will require additional treatment before they can be used on land. It is important to find out as soon as possible whether or not these processes are adequate, and if not, what are the least costly ways to bring them into conformance with requirements. This effort will be conducted by the Process Development Program. It responds to needs informally communicated by staff from Regions V, VI, VII and VIII.

- Energy technology. Energy technology in "treatment" of sludge primarily considers energy in pumping, dewatering and stabilizing sludge. There is great interest in maximizing methane generation and maximizing the energy return from the methane. A modular turbine is scheduled for evaluation at a California sewage treatment plant in 1981. A report on the use of solar energy in sludge treatment also is expected in 1981. Review of advances in energy conservation in sludge treatment are planned on a regular basis. These efforts will be coordinated with the Energy Conservation Research Program and support the needs of Region 1 and OWPO.

- Toxicants removal. Many sludges have levels of toxic metals high enough to cause concern in land application. Others have toxic organic contaminants that are of concern in ocean disposal and, in a few cases, could be of concern if sludge is utilized on land. Opportunities for disposal or use could be greatly expanded if these substances could be economically removed from sludge. Unfortunately, agents that remove metals and organic toxicants are radically different. Consequently, efforts have been concentrated on the goal most likely to be achieved--removal of metals. Techniques, such as extraction with hot acid, have proved successful but are not cost-effective under most circumstances.

  Current efforts are concentrating on improving the economics by conducting the metal removal in an electrochemical cell and depositing the metals on an electrode. Acid requirement is reduced and costs of re-precipitating the metals are avoided. No new approaches are planned until the present approach has been evaluated. The possibility of immobilizing toxics by some kind of treatment rather than removing them will continue to be considered, although this approach has not been fruitful. One research requirement (d) is not addressed by the current research program.

Conversion. The following nine needs have been expressed in the areas of thermal and non-thermal conversion:

a. Bulking agents for composting - OWPO(L)
b. Air emission controls for thermal conversion - OWPO(M)
c. Economics of co-disposal - OWPO(M)
d. Composting guide for small communities - OWPO(M)
e. Evaluating full-scale conversion systems, including special studies of thermal conversion - OWPO(H), Region II, Region VII
f. Improved methods of sludge processing and disposal at small POTWs - Region I(H), Region X(H)
g. Evaluating new European technology - Region II(H)
h. Evaluating vermicomposting - Region VI(H)
i. Fate of toxics from incineration - OPTS(M)

- Thermal processes. The primary need for conventional incineration of sludge has been to satisfy informational needs on air pollution discharges. These needs have been reasonably well satisfied by recent work. As other thermal processes are developed, this kind of information will have to be obtained for each new process. Some of the new thermal processes that have been developed are: starved-air combustion of sludge or sludge-solid waste mixtures; oxygen or air-blown gas producers that use sludge cake in conjunction with solid fuels such as coal; refuse-derived fuel or solid waste; and pyrolytic processes that convert sludge to oil and char or to a synthesis gas that can be converted to a gasoline-range fuel.

For starved-air combustion and gas producer processes, the major remaining need is to prove that they work on a large scale. For the pyrolytic processes, there is a need to not only prove the technology, but also to determine compatibility with wastewater treatment

Efforts to date have brought several processes to the brink of demonstration, but funds have not permitted proceeding beyond this point. Demonstration and evaluation will proceed as far as funds will permit. Current efforts will center on funding an operating period for the Eco-Rock pilot plant at Philadelphia (conversion of solid waste and sludge to aggregate), completing an evaluation of co-incineration at Duluth and air pollution studies at a number of co-incineration sites. Developments in thermal conversions are a high priority need of the Office of Water Program Operations and Region VII.

- Non-thermal conversion processes. The most outstanding non-thermal conversion process is composting. Success of unconfined composting has been outstanding although some development problems will inevitably arise as the process finds more application. Within-vessel composting is being developed to solve some of the problems of unconfined composting.

  Pilot-scale demonstration of a new approach to unconfined composting will be completed in 1981 (temperature control by air modulation). Within-vessel composting is being explored by Ohio State University and a report should be available in 1982. Needs defined in a and f above not met by ORD's present sludge management program.

Utilization on land. The research needs expressed by the Program and Regional Offices can be summarized as follows:

a. Fate of toxics from land-applied sludge - OPTS(M), OSW(H)

b. Adherence of sludge to crops - OSW(M)

c. Plant uptake mechanisms for trace metals - OSW(M)

d. Compare current methods for dietary cadmium exposure evaluation - OSW(M)

e. Cadmium uptake by leafy plants, peanuts and fruits - OSW(L)

f. Home garden studies of pathogens in sludge - OSW(M)

g. Home garden studies of PCBs in sludge - OSW(M)

h. Plant uptake of organics and trace metals (other than PCB, Cd, Pb) - OSW(M)

i. Regrowth prevention for pathogens in sludge - OSW(H)

j. Analyze sludge-derived fertilizers for pathogens - OSW(H)

k. Adherence of PCBs in sludge to crops - OSW(H)

l. Uptake of PCBs by root crops - OSW(H)

m. Accumulation of PCBs in beef and milkfat - OSW(H)

n. Plant uptake of lead - OSW(H)

o. Load application of sludge on non-food chain croplands - OSW(H)

p. Good management practices for contaminated sludges - OWPO(L)

q. Improved sludge processing information - OWPO(L)

r. Multi-media relative risk evaluations for sludge management - OWPO(L)

s. Ecological assessment of land application of sludge management - OWPO(L)

t. State-of-the-art health assessment for land application and followup studies - OWPO(H), OSW(H,M), Region IV(H)

u. Design manual for land application - OWPO(H), Region I(H), Region II(H), Region VIII(H)

v. Assist University of Connecticut study of sludge application to corn crops - Region I(H)

w. Improved methods of sludge processing and disposal at small POTWs - Region I(H)

x. Acceptability of landspreading of urban area sludges - Region II(H)

y. Monitoring of cadmium in sludge amended soils - Region V(H)

Categories for land-use projects are somewhat general, since virtually all projects are multipurpose. They are used below primarly for organizational purposes.

- Use on agricultural and disturbed land. Studies and demonstrations indicate that acceptability of sludge by farmers is vastly improved when the program is placed in the hands of people they trust (Ohio Farm Bureau Coopertive Agreement). Sludge offers unusual advantages in renovation of strip mines (State of Pennsylvania), sludge can be used on sandy soil with minimal impact (Rutgers University), and carefully controlled projects produce no environmental hazards (USDA at Minneapolis).

  Future needs call for the transfer of information to potential users of sludge rather than for more demonstrations. Plans are being made to involve farmer advisory organizations in a program to communicate the advantages of sludge use to farmers and to establish advisory centers for sludge users, staffed by people whose primary loyalty is to the sludge producer.

- Toxic substances. The toxic substances of concern are heavy metals and certain organic compounds. For the heavy metals, knowledge of concentration levels and effects is adequate for design of environmentally safe systems. Although our knowledge is far from complete, guidelines have been developed that permit sludge to be used on agricultural land within certain limits. Continuing research is needed to determine whether these guidelines are excessively conservative. Parallel studies are needed in the health field to determine whether the limitations for human ingestion of cadmium (the element of principal concern) are realistic.

  For toxic organic compounds, our knowledge of all aspects of the problem--analytical techniques, concentrations in sludges, effects on soil and groundwater, plant uptake, effects on food consumers--is rudimentary. The beginning steps are being made. Analytical techniques are being developed by others and the sludge management program is investigating uptake by plants and toxicity to plants of certain organic compounds. With information just now becoming available on the nature and concentration of toxic organic compounds in sludge, plans can be made for determining the impact of the toxicant on soil-plant systems and, equally important, the ability of the soil-sludge system to decompose the toxicant.

- Pathogens. The sludge management program has done much important work in establishing the density levels of pathogens in sludges and the reductions caused by treatment processes. Investigations are proceeding to solve the much more difficult problem of establishing the pathogen densities that are safe for certain kinds of disposal and utilization practices. An important phase of the land utilization project with the Ohio Farm Bureau (see above) is to determine whether there are any negative health effects on animals or humans from the use of sludge on agricultural land. Needs of the Office of Solid Waste reflect its keen interest in epidemiological studies to quantify illness risk caused by sludge utilization. Properly conducted epidemiological studies are extremely expensive and frequently inconclusive unless the effects are large. Epidemiological studies, carefully selected to maximize the likelihood of significant information, are being planned jointly with EPA's Health Effects Laboratory.

The needs which are not being addressed by current research are f, i, j, k, l, m, p, r, and w.

Table 4.3a

SCHEDULE OF R&D OUTPUTS

Municipal Sludge Management—Processing and Stabilization

LEGEND:

- ▲ Completed Project Outputs
- △ Proposed Project Outputs
- — Estimated Project Period

R&D OBJECTIVE	FY80 O D F A J A	FY81 O D F A J A	FY82 O D F A J A	FY83 O D F A J A	FY84 O D F A J A	FY85 O D F A J A	 O D
1. Dewatering and Conditioning							
a. Biennial report on cost, performance and design data on thickening and dewatering	▲ O		△ O		△ O		△ O
b. SOA report on chemical sludge handling	▲ O						
c. Technology assessment for dewatering to high-cake solids			△ F				
d. Data on to-feed rotary vacuum filter		△ F —— △ A					
e. Full-scale evaluation of dewatering devices			△ O		△ O		△ O
2. Disinfection and Stabilization							
a. Purifax Evaluation Report	△ D ——	—— △ O —— △ J					
b. SOA report on lime stabilization	▲ F						
c. SOA report on Vermicomposting	▲ F						
d. Report on pathogen survival in aerobic digestion			△ D				
e. Evaluation of new and innovative methods			△ O		△ O		△ O
f. Report on gamma ray irradiation for stabilization		▲ O					
g. Procedure for characterizing sludge stability			△ O	△ J			
h. Determine pathogen reductions in sludge from extended aeration and oxidation ditch plants				△ J	△ A		
3. Energy-Related Sludge Technology							
a. Report on improved anaerobic digester and energy production		△ O —— △ J					
b. Solar energy and digester gas use demonstration	▲ O	△ J					

* Projects that could be completed with funding above FY81 level.

LEGEND:

▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

Table 4.3a

SCHEDULE OF R&D OUTPUTS

Municipal Sludge Management — Processing and Stabilization

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
c. Demonstration of modular gas turbine for POTW energy													△	—	—	—	—	—	△																			
4. Toxicants Removal																																						
a. Report on heat and acid treatment for conditioning heavy metals removal	▲																																					
b. Assessment of present technologies for heavy metals removal											△																											
c. Heavy metals removal by centritugal classification												△																										
d. Bench-scale evaluation of heavy metals removal process (U.Carbide), followed by pilot-scale evaluation													△															△										

* Projects that could be completed with funding above FY81 level.

Table 4.3b

LEGEND:

- ▲ Completed Project Outputs
- △ Proposed Project Outputs
- — Estimated Project Period

SCHEDULE OF R&D OUTPUTS

Municipal Sludge Management—Conversion and Energy Recovery

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
1. Evaluate Thermal Processes and Energy Recovery																																						
a. Evaluation of co-incineration project		△	—	—	—	—	—	—	—	△																												
b. Evaluation of 2nd co-incineration process (Eco-Rock process)																												△										
c. Evaluation of pyrolysis with RDF addition and high solids cake																															▲							
2. Characterize Emissions from Sludge Disposal Facilities																																						
a. Reports on sludge incinerator emissions	▲	—	—	—	—	—	—	—	△																													
b. Evaluation of incinerators with best SOA pollution control devices									△	—	△																											
c. Summary report on incinerator emissions and evaluation of advanced control technologies																															△							
d. Determine emissions from co-incineration																					△																	
3. Evaluate Composting and Other Conversion Processes																																						
a. Report on European technology and leading within-vessel process	▲								△																													
b. Additional evaluations of within-vessel processes									△																													
c. Report on composting on a barge								△	—	△																												
d. Demonstration of unique U.S. composting process																			▲																			
e. Optimization of composting															△												△											
4. Study Emerging Resource Recovery Processes																																						
a. Evaluation of wet oxidation in a deep-well reactor					△	—	—	—	—	—	—	△																										

* Projects that could be completed with funding above FY81 level.

Table 4.3b

LEGEND:

▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

SCHEDULE OF R&D OUTPUTS

Municipal Sludge Management—Conversion and Energy Recovery

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
b. Contractor evaluation of deep-well wet oxidation																						△													△			
c. Feasibility study of liquefaction of sludge to produce synthetic fuel																			△																			
d. NATO-CCMS study, sludge disposal with energy recovery																							△															
e. Review of novel sludge conversion technologies																	△																					
f. Evaluation of sludge gasification systems													△												△													
g. Evaluation of novel sludge and solid waste co-disposal process														△												△												

* Projects that could be completed with funding above FY81 level.

LEGEND:

▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

Table 4.3c

SCHEDULE OF R&D OUTPUTS

Sludge Management — Land Application Management and Disposal

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
1. Impacts of Toxicants on Crop Response and Site Life																																						
a. Chemistry of metals in sludge-amended soils	△	—	—	—	—	—	—	—	—	—	△																											
b. Effects of long-term use		△	—	—	—	—	—	—	—	—	—	—	—	△																								
c. Impacts of prolonged application of various rates							△	—	—	—	—	—	—	△																								
d. Cumulative loadings of metals vs. annual sludge application						▲					△																											
e. Soil factors affecting metal absorption														△																								
f. Fate & effects of toxic organics in sludge applied to agricultural land																				△																		
g. Crop uptake of metals under various soil properties																									△													
2. Sludge Management Practices for Soil Systems																																						
a. Sludge use in sandy coastal plain soils			△	—	▲																																	
b. Demonstration of sludge use to reclaim acidic mine spoils			△	—	—	—	—	—	—	—	△																											
c. Proper site management on agricultural soils														△																								
d. Fate/effects from various land application management schemes																									△													
e. Prepare a design manual																		△																				
f. Develop a Farmer Advisory Service on sludge use (milestone is starting date)															△																							
3. Assess Fate and Effects of Pathogenic Organisms																																						
a. Static pile composting	△	—	—	—	—	—	△	—	—	—	—	—	—	—	△																							

*Projects that could be completed with funding above FY81 level.

Table 4.3c

SCHEDULE OF R&D OUTPUTS

Municipal Sludge Management — Land Application Management and Disposal

LEGEND:
▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

	FY80						FY81						FY82						FY83						FY84						FY85							
R&D OBJECTIVE	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
b. Helminth transmission from sludge use	△	—	—	—	—	—	—	—	△																													
c. Pathogen requirements for RCRA	▲																																					
d. Demonstration of beneficial use of sludge on farms (including epidemiological study)																				△																		
e. Effectiveness of sludge storage in diminishing parasitic ova																					△	△																
f. Parasites in sludge																			△																			
4. Assess the Use of Sludge for Energy & Other Non-Food Chain Crops																																						
a. Sludge use in western forest				▲																																		
b. Feasibility of energy crop production with sludge		△	—	—	—	—	—	—	—	—	—	△																										
c. Non-food chain crops from sludge		△	—	—	—	—	—	—	▲																													
d. Sludge use to grow trees in Eastern U.S.																				△																		
5. Assess Long-Term Impact of High Rate Application on Soil															△																							
a. Assessment of high rate application																																			△			
b. Evaluation of sludge landfilling																			△																			
c. Management document for sludge use in mine reclamation																																						

*Projects that could be completed with funding above FY81 level.

4.5 PLANT OPERATIONS AND DESIGN RESEARCH

4.5.1 Research Program Description and Objectives

The ORD plant operations and design program, including the automation and instrumentation subsection, supports Titles I through IV of the Clean Water Act of 1977 (PL 95-217). Specifically, the program develops information leading to improved training, as required under Sections 104(g) and 109(b) of Title I of the Act. Principal program responsibility is for supporting the cost effective facility planning, design and construction of publicly owned municipal treatment facilities, including the planning, management and conduct of plant start-up activities. A second major program responsibility is the investigation and development of technologies, procedures and techniques to improve the compliance of POTWs as required by Titles III and IV of the Act.

Overall program goals and objectives are to develop, demonstrate and disseminate information leading to:

- Improved compliance of new and existing POTWs
- Improved unit process and total plant reliability
- Reduced construction cost for municipal treatment plants and collection systems
- Improved fiscal management of municipal treatment works
- Improved automation and instrumentation technology which will achieve better performance of water pollution control systems and/or cost reduction

Activities of the program have broadened during the past few years as a result of a 3-1/2 year, 30-plant comprehensive survey to identify and prioritize the causes of municipal non-compliance. As a result of this study, the plant operations and design program also provides technical assistance on a high priority request basis to EPA's Office of Enforcement, Office of Water Program Operations and the ten Regional administrators. The program also reviews and comments on Agency policy, PRMs and guidance materials and participates in the development of national compliance and construction grants strategies.

4.5.2 Recent Research Accomplishments

Since completion of the National Survey that identified and ranked over 70 specific problems with non-complying plants, the plant operations and design program has undertaken a number of projects to satisfy identified needs. Completed outputs are shown as darkened triangles in the milestone matrix.

Program accomplishments. High impact accomplishments of the plant operations and design program are summarized below.

- As a result of the large number of noted design deficiencies, a study was completed that identified and developed specific remedial measures for 3,260 separate design deficiencies for both existing and new plant construction. (Report in press.)
- Because of the impact of sidestreams on plant performance noted during the National Survey and because of needs identified by EPA Regions and operating programs, a study which outlines specific design modifications and operational techniques that can be used to ameliorate or eliminate the adverse impact of sidestreams on new or existing plants was completed (Report in press). Sidestreams from sludge dewatering and heat treatment processes were identified as the most troublesome.
- Based on the severe non-compliance problems noted during the National Survey, a comprehensive plant evaluation program was developed to address the major factors causing non-compliance. The developed procedure, called the Composite Correction Program (CCP), was tested at 12 separate facilities and, in each case, resulted in bringing non-complying plants into compliance. This technique was endorsed by EPA's Office of Enforcement and has been incorporated into the Agency's National Compliance Strategy. ORD has further developed a CCP protocol to provide guidance to the private sector to employ this technique. It is estimated that 70% of all non-complying plants can be brought into compliance using this approach. It is currently being demonstrated statewide in Colorado under a recent grant awarded by the plant operation and design program.
- When problems with POTW mechanical components were identified as a major factor in non-compliance, a study was undertaken to quantify the reliability of well maintained mechanical components throughout the United States (Report in press). This study is the first of its kind to document actual mean time between failures for mechanical plant components. As a follow-up to this effort, a feasibility study was completed to determine if a construction grants hotline for mechanical component problems would be useful to the operations and engineering community. This concept is now in operation for belt-filter presses and is co-sponsored by OWPO.

- As it became apparent that private sector expertise would be required to solve the municipal compliance problem, an in-house study was conducted to determine private sector expertise in plant operations. In analyzing the 107 responses to a request for qualifications, it was found that 25% of the firms provide full operational services, while 60% of the firms provide technical assistance related to compliance problems. This study further concluded that private sector expertise would improve technical assistance related to compliance problems. This study concluded that private sector expertise would improve as more incentives were provided to the municipalities through tougher EPA enforcement. (Unpublished report.)
- Within the area of automation and instrumentation, preliminary studies indicated that basic technology development in the area of sensor reliability and process control of treatment processes was necessary as a foundation upon which automation systems could be constructed. Consequently, major efforts have been made to devise instrumentation specifications and certification standards for commonly applied on-line sensors. This effort is resulting in production of model instrument specifications which can be used by municipal officials, consulting engineers and construction grant officials to make judgments on the purchase and application of instruments for monitoring and control applications. Evaluations of process control strategies for liquid treatment unit operations in treatment plants were conducted and those found acceptable were incorporated into a recently published design manual (EPA 600/8-80-028). A major effort is currently under way in the area of developing sludge conditioning and dewatering strategies.

The following represents a summary of major program output documents completed during the last fiscal year and those programmed during FY 81.

Program Area*	Reports Completed in FY 80	To Be Completed in FY 81
1	3	1
2	1	1
3	4	2
4	4	4
5	2	2
6	0	2
7	1	3
	15 total	15 total

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*Numbers refer to major program areas shown on milestone chart (Table 4.4a)

Publications completed in 1980 which deal with plant operations and design are listed below:

Crosby, R.M., and Bender J.H., "Hydraulic Considerations that Affect Secondary Clarifier Performance," Technology Transfer, March 1980.

"Performance of Biological Wastewater Treatment Plants, Effects of Toxic Pollutants," Draft Report, September 1980.

"Hourly Diurnal Variations in Publicly Owned Wastewater Treatment Facilities," Draft Report, April 1980.

"Operation and Maintenance Considerations of Land Treatment Systems," Draft Report, December 1980.

"Review of RBC Design Procedures, and Process, O&M, Equipment and Power Performance," Draft Report, September 1980

Chesner, W.H., and Iannone, J.J., "Current Status of Municipal Wastewater Treatment with RBC Technology in the U.S.," Proceedings: First National Symposium/Workshop on Rotating Biological Contactor Technology, February 1980

"Evaluation of Design, Operation, Maintenance and Administrative Factors Limiting Treatment Plant Performance - Phase II," EPA 600/2-80-129, August 1980.

"Model Protocol for the Comprehensive Evaluation of Publicly Owned Treatment Works Performance and Operation," Final Report.

4.5.3 Current Research Plan

The major program outputs milestone chart for fiscal years 1980-1985 (Table 4.4a) contains details on specific program outputs. Entries for which no milestone appears are tasks which will, at some future time, contribute to a major research output.

New program directions and initiatives. From FY81 through FY85 the plant operations and design program will continue to support the legislatively mandated national construction grants program and will respond to changes in that program as dictated by changing national needs.

Emphasis will be placed on early identification and examination of critical operating parameters for emerging and alternative technologies before characteristic O&M problems develop. This is considered critical because of the large impetus given to new technologies as a part of the I/A technology program mandated under the Clean Water Act. Many of these technologies are heavily mechanically oriented, involve new unit operations and are completely new to present day plant operating personnel. Emphasis will also be placed on reduction of plant operating costs to meet current requirements for secondary treatment or less stringent future ones.

For newly constructed plants, program efforts will continue to improve design criteria and to examine new concepts such as fail-safe design practices, as well as the use of new planning and implementation concepts such as generic facility plans and certain turn-key design and construction practices.

The program will also continue to develop and maintain the computerized plant operation and performance data base. The effort will be extended to include plant operating costs and will concentrate on improving methods for reporting data on the management of sewer collector systems.

As a new initiative, the program proposes to undertake a comprehensive investigation of design and operational deficiencies of sludge handling processes with emphasis on identification of capacity-limiting problems, equipment incompatability and lack of process control. An initial assessment study will be completed in FY81. Results from this study will provide future program direction and an estimate of budget needs. It is anticipated that $300-500K will be needed above base program requirements over a 2-3 year period.

Another new initiative will be the establishment, within the program, of a group of experts knowledgeable in performance problems at POTWs. This group will consist of three engineers who will direct the efforts of a number of contractors. A municipality will contact this group who, traveling at the municipality's expense, will visit the site and assess the types of problems limiting the plant's performance. After the problems have been assessed, EPA contractors, under different level of effort contracts, will provide solutions to the problems. The contractor, paid by EPA, will deal directly with the municipality. This new initiative will require three new positions and from $500-1000K per year to implement.

A long-term goal in the automation and instrumentation area is to develop procedures to optimize a series of unit operations and/or processes to achieve a specific discharge goal. In such a situation, not all of the processes need be optimized in order to achieve the most cost-effective solution. A modest amount of technology transfer activity is also planned to ensure that these developments are transmitted to the user community. Most important is the effort starting next year to provide training seminars in procedures of selecting, specifying, installing and maintaining instrumentation.

A new initiative is planned in the area of system automation which deals primarily with the use of computers to aid in the operation of single treatment plants, pump stations and networks of treatment plants. This area of activity will explore and develop potential cost advantages of the use of modern computer technology. A start in this direction was made in the past year with studies of the computer assisted operation, maintenance and remote monitoring of a treatment plant. These studies have indicated significant reductions in the cost of treatment plant operation and maintenance, in conjunction with improved plant performance. New inexpensive yet very powerful microprocessors and minicomputers will also be examined. These units are capable of taking over all of the process control operations at a modest sized 1-5 mgd treatment plant. The concept of local process control by microprocessors reporting to a supervisory control minicomputer at a large treatment plant will also be explored. Finally, areawide management of a network of plants will be tested. The latter will include flow routing and sewer storage of storm flows.

4.5.4 ORD Response to Agency Research Requirements

The plant operations and design program is responsive to several groups. The most recent needs formally submitted to the plant operations and design program by these groups are summarized below.

a. Design information series for professional society impact - OWPO(H)
b. Develop design guidelines for new and improved processes - OWPO(M)
c. Update design information of guidelines - OWPO(M)

d. Atypical wastewater treatment - OWPO(L)
e Formation of technical assistance group for POTWs- OWPO(L)
f. Toxics formation in POTWs due to design processes, e.g., super chlorination - OWRS(H)
g. Methods to reduce energy consumption at POTWs - Region I(H)
h. Methods to improve operational efficiency - Region I(H)
i. Methods to identify design deficiencies - Region I(H)
j. Development of computer models of biological wastewater treatment processes - Region I(H)
k. Refresher courses for operators - Region IV(H)
l. Evaluate types of clarifiers - Region IV(H)
m. Guidelines to select specific unit processes - Region IV(H)
n. More specific POTW design criteria - Region IV(M)
o. Guidelines to justify AWT treatment processes - Region V(H)
p. Continuation of technology transfer - Region V(H)
q. Reliability of sand, multi-media and other final filters - Region V(H)
r. Demonstration of automation of small POTWs - Region VII(H)
s. Design parameters for optimum clarifier performance - Region VIII(H)
t. Improved supernatant quality in anaerobic digestion - Region VIII(H)
u. Reliability of NH_3 - N reduction in cold climes - Region VIII(H)

In addition to the above list of needs, the program has developed a comprehensive set of research needs based on the results of the 3-1/2 year National Survey. Listed in Table 4.4b is a priority ranking of 70 factors that were shown to limit POTW compliance.

Elimination or reduction of the impact of the major factors listed in Table 4.4b were considered priority needs in the development of the plant operation and design strategy and the formulation of the sub-program area goals.

The research program/problem area matrix (Table 4.4c) describes eight program areas of the plant operations and design program and the specific needs that each area and area project satisfies. The milestone matrix (Table 4.4a) indicates major program outputs for FY80 through 85.

Several groups indicated high priority needs related to improved design information for municipal wastewater treatment processes. The plant operations and design program is addressing these needs through research to improve treatment process operation and design. These results as well as relevant research results from other sources are being assembled into a usable format that will be disseminated through the Design Information Series. Design Information Series (DIS) documents are designed to supplement the existing body of information used for the design of POTWs. These information documents, prepared in conjunction with OWPO, ASCE and WPCF, will be based on the latest results from EPA-sponsored and other full-scale research studies. They will contain full-scale performance data and other state-of-the-art technical information and will provide, in a condensed format, a synopsis of both the methods and scientific basis for the rational design of municipal treatment works unit processes, systems and system components. Improved guidance and design information will be disseminated for both conventional and newer technologies through the publication of four to six documents per year for the next five years. The documents will undergo an intensive two-step peer review process to insure the highest possible technical quality before final publication. The overall development of the information documents is under the direction of an executive committee including membership from EPA, ASCE and WPCF. The first five documents, to be finished in 1981, cover the subjects of hydraulic peaking, rotating biological contactor design, land application, effects of sidestreams on biological treatment plants and aeration devices.

Needs have been identified relative to the performance of various unit processes. Research is proceeding and new efforts are planned that will improve the hydraulics and performance of secondary clarifiers. Design deficiencies limiting performance have been identified and potential correction procedures developed. Control of sidestreams, including those from anaerobic digesters, have been investigated from both a design and operational viewpoint.

Research will continue on the development of methods and procedures for improved systems reliability. Completed studies have investigated the inherent stability/reliability of biological processes and the reliability of conventional mechanical components. Future efforts will include investigations of the reliability of various physical tertiary treatment processes comparing improved reliability with increased costs. Overall eliability guidelines will be developed that will allow the engineer to consider reliability concepts in his designs.

With the Agency stressing use of innovative technologies, the plant operations and design program perceives a need to evaluate the O&M of these nonconventional technologies. The program has observed a close interrelationship between process design and process operability. Inabilities to operate the process can be related to design deficiencies. In the development of new technologies, operability may not be considered until after the technology is in use. By this time, design deficiencies limiting operability and reliability may be prevalent throughout the installation. Evaluations performed earlier in the development of the process could identify such deficiencies and eliminate them.

With the continuing compliance problem in municipal wastewater treatment facilities, the program perceives a need to continue to assess selected problem areas related to municipal facility compliance. This will assist in the solution of problems and in the assessment of needs for further research.

The major research requirements identified in the latest compilation of Agency needs which are addressed by the automation and instrumentation (A/I) activity are: the general requirement to improve plant operation, maintenance and reliability; the development of computer-based process control strategies; and the application of automation technology to small treatment plants. In addition, Table 4.4b presents some specific factors limiting plant performance which are now and will in the future be addressed by automation research.

The A/I activity consists of four areas: instrument development; process control strategy development; system automation; and technology transfer. The activities in these areas respond both in broad-based and specific ways to the needs referred to above. The instrumentation work is broad-based in that it will ensure the availability of good quality instruments for all types of monitoring, especially that associated with process control efforts. The work on control stategies is more specifically focused, concentrating first on conventional sludge handling and later on novel biological treatment processes.

A number of needs specified by the Program and Regional Offices are not addressed by the current research plan. The gathering of information on toxics formation in POTWs as a result of design processes is not currently planned. In addition, Region V's request for guidelines to justify advanced waste treatment processes is not met by any scheduled projects. Other unaddressed needs include a study on the reliability of sand, multi-media and other final filters (Region V), work on improving supernatant quality in anaerobic digestion and an assessment of the reliability of NH_3-N reduction in cold climes (Region VIII).

Table 4.4a

SCHEDULE OF R&D OUTPUTS
Plant Operations and Design

LEGEND:
- ▲ Completed Project Outputs
- △ Proposed Project Outputs
- — Estimated Project Period

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
1. Problem Assessment Studies Related to POTW Compliance Problems																																						
a. National O&M cause and effect survey	▲																																					
b. Assessment of sludge handling problems													△																									
c. Evaluation of on-site training programs																																						
d. Evaluation of peak flows at POTWs								▲																														
e. Evaluation of RBC operation and performance								▲																														
2. O&M Evaluations of Non-Conventional Technologies																																						
a. O&M of land treatment systems								▲																														
b. Evaluation of bio-fouling fine bubble diffusers																																						
c. O&M of ozone disinfection systems													△																									
d. O&M considerations of emerging technologies																			△																			
3. Improved Plant Operations and Design																																						
a. POTW design deficiencies								▲																														
b. Improved secondary clarifier performance										△																												
c. Impact of flow variations on secondary clarifier																																						
d. Evaluation of improved inlet design																																						
e. Evaluation of in-channel clarifier																																						
f. Impact of sidestreams on POTW performance								▲																														
g. Computerized data base																																						
h. Improved O&M of land treatment systems																																						

✱ Projects that could be completed with funding above FY81 level.

LEGEND:

- ▲ Completed Project Outputs
- △ Proposed Project Outputs
- — Estimated Project Period

Table 4.4a

SCHEDULE OF R&D OUTPUTS
Plant Operations and Design

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
i. CCP protocol					▲																																	
j. CCP demonstration	▲																																					
k. Develop approach for evaluating water quality management strategies																																						
l. Evaluation of methods for evaluating standards & monitoring for water quality management																																						
4. Design Information Series (DIS)																																						
a. DIS #1 impact of peak flows on primary										△																												
b. DIS #2 impact of peak flows on suspended growth											△																											
c. DIS #3 impact of peak flows on attached growth											△																											
d. DIS #4 RBC											△																											
e. Other DIS documents																	△					△	△						△						△			
5. Improved Systems Reliability																																						
a. Reliability of biological systems including toxics							▲																															
b. Reliability of mechanical components							▲																															
c. Reliability guidelines														△																								
d. Application of fail-safe design to POTWs																			△																			
6. Cost of Operation, Maintenance and Management																																						
a. Development of O&M cost data collection procedures												△																										
b. Collection of historical O&M cost data																			△																			
c. Methods for reduction of O&M costs																									△													

*Projects that could be completed with funding above FY81 level.

Table 4.4a

SCHEDULE OF R&D OUTPUTS
Plant Operations and Design

LEGEND:
▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
7. Utilities Management																																						
a. Develop of model management systems (MARS)																			△																			
b. Demonstration of centralized management (CCWDA)																																						
c. Evaluation of remote monitoring								▲																														
d. Circuit rider optimization model													△																									
8. Information Dissemination and Technical Assistance																																						
a. National conference on compliance problems																																						
b. Provide technical assistance on request basis to 10% of program resources							▲						△						△							△					△						△	
9. Automation and Instrumentation - Certification and Development																																						
a. Specification for flowmeters									▲																													
b. Specifications for dissolved oxygen meters									▲																													
c. Specifications for chlorine analyzers									▲																													
d. Specifications for organic analyzers															△																							
e. Specifications for suspended solids															△																							
f. *Specifications for N&P measurement																					△																	
g. Start-up of certification laboratory																					△																	
h. *Toxanalyzer specifications																											△											
i. Other specific pollutants																																	△					

* Projects that could be completed with funding above FY81 level.

LEGEND:

▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

Table 4.4a

SCHEDULE OF R&D OUTPUTS
Plant Operations and Design

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
10. Automation and Instrumentation - Technology Transfer																																						
a. Preparation of technology transfer symposium									▲																													
b. Presentation of technology transfer symposium															△																							
c. *Preparation of operator training course															△																							
d. Energy savings design manual																					△																	
e. *Computer system selection and use manual																											△											
f. Preparation second generation technology transfer manual																																	△					
11. Automation and Instrumentation - Process Control																																						
a. Control strategy anaerobic digestion									▲																													
b. Control strategy vacuum filtration									▲																													
c. Control strategy incineration															△																							
d. Control strategy centrifuge															△																							
e. Control strategy conventional activated sludge															△																							
f. Control strategy filter press																					△																	
g. Control strategy expanded bed biological contactor																					△																	
h. Control strategy RBC units																											△											
i. *Control strategy novel biological treatment																											△											
j. *Control strategy sludge treatment system																																	△					

* Projects that could be completed with funding above FY81 level.

LEGEND:

▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

Table 4.4a

SCHEDULE OF R&D OUTPUTS
Plant Operations and Design

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
k. *Optimization procedure series of treatment processes																																	△					
12. Automation and Instrumentation - System Automation																																						
a. Computer assisted O&M (man in loop)									▲																													
b. Remote monitoring of T.P. by alarms									▲																													
c. *Marketing study of use of new computer concepts															△																							
d. Pilot plant use of microprocessor control for activated sludge plant															△																							
e. *Demonstration of use of microprocessor control for activated sludge plant																					△																	
f. Demonstrate use of remote sensors for enforcement, and treatment plant protection																					△																	
g. *Demonstrate use of "smart computer to run simple treatment plant"																											△											
h. Start demostration of areawide management																																	△					

* Projects that could be completed with funding above FY81 level.

Table 4.4b

COLLECTIVE RANKING OF FACTORS LIMITING PLANT PERFORMANCE

LIMITING FACTOR			NO. OF TIMES FACTOR WAS	
Factor	Area	Description	Ranked #1	Noted
1	O	Operator Application of Concepts & Testing to Process Control	24	39
2	O	Process Control Testing	0	67
3	D	Infiltration/Inflow	9	56
4	O	Sewage Treatment Understanding	9	50
5	O	Technical Guidance	7	47
6	D	Sludge Wasting & Return Capability	9	43
7	D	Secondary Process Controllability	3	55
8	D	Secondary Process Flexibility	3	37
9	O	O&M Manual Inadequacy	0	40
10	D	Aerator	6	27
11	D	Sludge Treatment	3	36
12	D	Industrial Loading	4	27
13	O	Staff Training	0	31
14	D	Secondary Clarifier	3	26
15	O	Performance Monitoring	0	31
16	D	Ultimate Sludge Disposal	1	30
17	A	Plant Administration, Familiarity with Needs	2	21
18	D	Disinfection	1	20
19	A	Plant Staff - Number	2	22
20	D	Plant Hydraulic Loading	0	18
21	A	Plant Staff - Plant Coverage	0	26
22	M	Spare Parts Inventory	0	23
23	D	Laboratory Space & Equipment	0	30
24	D	Return Process Stream	1	18
25	O	Equipment Malfunction	2	17
26	M	Lack of Preventive Maintenance Program	1	20
27	D	Alternative Power Source	0	24
28	D	Organic Loading	7	13
29	M	General Housekeeping	0	17
30	M	Maintenance Scheduling & Recording	0	19
31	A	Administration Policies	2	15
32	A	Plant Staff Productivity	0	17
33	A	Insufficient Funding	1	16
34	M	Manpower	0	14
35	D	Preliminary Unit Design	0	20
36	A	Staff Motivation	0	19
37	A	Working Conditions	0	18
38	D	Alarm Systems	0	19
39	M	Critical Parts Procurement	0	14
40	D	Flow Proportioning to Units	0	12
41	O	Staff Aptitude	0	13
42	D	Inoperability Due to Weather	0	12
43	A	Staff Supervision	0	13
44	D	Primary Units	1	9
45	M	Equipment Age	0	14

O = Operation; D = Design; A = Administration; M = Maintenance

Table 4.4b

COLLECTIVE RANKING OF FACTORS LIMITING PLANT PERFORMANCE

LIMITING FACTOR			NO. OF TIMES FACTOR WAS	
Factor	**Area**	**Description**	**Ranked #1**	**Noted**
46	O	O&M Manual - Use by Operators	0	12
47	A	Salary	0	12
48	D	Lack of Standby Units for Key Equipment	0	9
49	D	Lack of Unit By-Pass	0	12
50	M	Technical Guidance - Emergencies	0	10
51	M	Availability of Preventive Maintenance Ref.	0	10
52	D	Flow Backup	0	7
53	O	Staff - Level of Education	0	9
54	D	Toxic Loading	1	8
55	D	Submerged Weirs	0	6
56	D	Plant Location	0	6
57	O	Staff Level or Certification	0	8
58	O	Staff - Insufficient Time on Job	0	7
59	M	Staff Expertise - Emergencies	0	9
60	D	Seasonal Variation Loading	0	7
61	A	Unnecessary Expenditures	0	7
62	D	Process Automation for Control	1	6
63	A	Personnel Turnover	0	4
64	O	Shift Staff Adequacy	0	3
65	D	Unit Accessibility	0	3
66	D	Process Accessibility for Sampling	0	4
67	D	Process Automation for Monitoring	0	2
68	D	Equipment Accessibility for Maintenance	0	2
69	A	Bond Indebtedness	0	0
70	D	AWT Units	0	0

O = Operation; D = Design; A = Administration; M = Maintenance

Table 4.4c

NATIONAL SURVEY, EPA PROGRAM AND OTHER IDENTIFIED NEEDS ADDRESSED BY POD PROGRAM

PLANT OPERATIONS AND DESIGN RESEARCH PROGRAM AREA	National Survey Problem Area In*				Operating Program Needs	Regional Office Needs	Other Identified Needs**	OBJECTIVES AND GOALS
	A	D	O	M				
1. PROBLEM ASSESSMENT STUDIES RELATED TO POTW COMPLIANCE PROBLEMS								Conduct field studies to identify and quantify administration, design, operational, and maintenance problems with POTWs.
a. National O&M Cause and Effect Survey	•	•	•	•				
b. Assessment of Sludge Handling Problems		•	•		•	•	•	
c. Evaluation of On-Site Training Programs	•				•		•	
d. Evaluation of Peak Flows at POTWs		•			•	•		
e. Evaluation of RBC Operation and Performance		•	•	•		•		
2. O&M EVALUATIONS OF NON-CONVENTIONAL TECHNOLOGIES								Conduct detailed investigations of operation, maintenance, and management factors that affect the overall performance of non-conventional and emerging technologies. Objectives are to identify principle O&M factors affecting performance before they become problem areas.
a. O&M of Land Treatment Systems		•	•	•		•	•	
b. Evaluation of Bio-Fouling Fine Bubble Diffusers							•	
c. O&M of Ozone Disinfection Systems							•	
d. O&M Considerations of Emerging Technologies						•	•	
3. IMPROVED PLANT OPERATION AND DESIGN								Objectives are to identify all major design and operational deficiencies of new and existing plants, and develop improved design, operational, and management techniques to improve overall plant performance on both a single plant and basin-wide or state-wide basis.
a. POTW Design Deficiencies		•		•	•	•	•	
b. Improved Secondary Clarifier Performance		•	•	•		•	•	
c. Impact of Flow Variations on Secondary Clarifier		•	•	•		•	•	
d. Evaluation of Improved Inlet Design		•	•	•		•	•	
e. Evaluation of In-Channel Clarifier							•	
f. Impact of Sidestreams on POTW Performance		•	•	•	•	•	•	
g. Computerized Data Base	•				•	•	•	
h. Improved O&M of Land Treatment Systems			•	•	•		•	
i. CCP Protocol					•		•	
j. CCP Demonstration	•	•	•	•	•		•	
k. Develop Approach for Evaluating Water Quality Management Strategies	•				•		•	
l. Evaluation of Methods for Evaluating Standards & Monitoring for Water Quality Management	•				•		•	

A —Administration Needs
D —Design Needs
O —Operation Needs
M —Maintenance Needs

*Indicates research program, addresses one or more specific needs identified by National Survey or EPA program offices.

**Includes needs input from State, ORD staff and other sources.

Table 4.4c

NATIONAL SURVEY, EPA PROGRAM AND OTHER IDENTIFIED NEEDS ADDRESSED BY POD PROGRAM

PLANT OPERATIONS AND DESIGN RESEARCH PROGRAM AREA	National Survey Problem Area In*				Operating Program Needs	Regional Office Needs	Other Identified Needs**	OBJECTIVES AND GOALS
	A	D	O	M				
4. DESIGN INFORMATION SERIES (DIS)								The DIS is a newly established set of publications that represent the best available state of the art design information for the most commonly used municipal treatment technologies. The documents summarize critical design/performance relationships as documented by pilot and full-scale experience. DIS will be prepared by EPA, undergo peer review, and be jointly published by EPA/ASCE/WPCF.
a. DIS #1 Impact of Peak Flows on Primary		•			•		•	
b. DIS #2 Impact of Peak Flows on Suspended Growth		•			•		•	
c. DIS #3 Impact of Peak Flows on Attached Growth		•			•		•	
d. DIS #4 RBC		•			•		•	
e. Other DIS Documents		•			•		•	
5. IMPROVED SYSTEMS RELIABILITY								This program includes investigation and documentation of the physical, chemical, and biological reliability of unit processes and mechanical components, as well as defining the total system reliability as a function of component design and capital cost, influent variations, and operation.
a. Reliability of Biological Systems Including Toxics	•	•				•		
b. Reliability of Mechanical Components		•				•		
c. Reliability Guidelines		•				•		
d. Application of Fail-Safe Design to POTWs					•			
6. COST OF OPERATION, MAINTENANCE AND MANAGEMENT								Area objectives are to develop improved O&M cost data for existing wastewater treatment plants and collector sewers and to develop and demonstrate improved cost accounting and management approaches.
a. Development of O&M Cost Data Collection Procedures	•	•	•	•			•	
b. Collection of Historical O&M Cost Data			•	•			•	
c. Methods for Reduction of O&M Costs			•	•			•	
7. UTILITIES MANAGEMENT								Develop and demonstrate improved utilities' management techniques including use of computers and microprocessors for collection of data from remote facilities, use of centralized management and fiscal management techniques.
a. Development of Model Management Systems (MAMS)	•						•	
b. Demonstration of Centralized Management (CCWDA)	•						•	
c. Evaluation of Remote Monitoring	•						•	
d. Circuit Rider Optimization Model	•						•	
8. INFORMATION DISSEMINATION AND TECHNICAL ASSISTANCE								Disseminate program results of high impact and interest to EPA, states, consultants, local governments and other interested parties. Provide technical assistance to EPA Regional Offices and Headquarters. Provide policy and program guidance to EPA Headquarters offices.
a. National Conference on Compliance Problems	•					•	•	

A —Administration Needs
D —Design Needs
O —Operation Needs
M —Maintenance Needs

*Indicates research program, addresses one or more specific needs identified by National Survey or EPA program offices.

**Includes needs input from State, ORD staff and other sources.

4.6 LAND APPLICATION OF WASTEWATER AND AQUACULTURE RESEARCH

4.6.1 Research Program Description and Objectives of Land Application of Wastewater

The overall objective of research in the area of land application is to fully develop design and operating parameters for the three types of systems, slow rate (irrigation), rapid infiltration and overland flow. To achieve this goal, projects are directed to understanding mechanisms involved in the natural processes, studies of treatment effectiveness for various pollutants and environmental effects related to groundwater, soil, vegetation and other media and ecosystems. Close coordination and cooperation are maintained with HERL to evaluate potential health effects related to land application of municipal wastewater.

The five major objectives of this area of research are:

- Development of reliable design and operating criteria for nationwide application of the three land treatment processes (slow rate, rapid infiltration and overland flow)
- Clarification of fundamental mechanisms involved in plant-soil-water relationships so that more efficient operation can be achieved
- Development of operating and management practices to minimize or prevent any adverse effects of system operations
- Transfer and dissemination of information to regulatory agencies, municipalities, engineers and other potential users
- Cooperative liaison with ongoing research in health effects, land application of sludge and groundwater quality

4.6.2 Recent Research Accomplishments

Several major accomplishments were achieved during the past year. Some were the culmination of long-term projects, while others were outputs resulting from specific requests of relatively short duration. The following are the most significant:

- Studies of ten existing systems, including both slow rate and rapid infiltration, have been completed. These systems were located to represent a variety of climatic conditions and operating practices. Effects on soils, groundwater, crops and surface waters were evaluated. Reports have been published for all ten studies. (EPA 600/2-79-144, Dickenson, N.D.; EPA 600/2-78-084, Hollister, CA; EPA 600/2-79-145, Milton, WI; EPA 600/2-79-047, Rosell, NM; EPA 600/2-79-171a,b, Tooele, VT; EPA 600/2-79-072, Vineland, NJ; EPA 600/2-79-068, Lake George, NY; EPA 600/2-78-131a,b, San Angelo, TX; EPA 600/2-80-061, Mesa, AZ; EPA 600/2-80-080, Camarillo, CA). The results of these various studies indicate that the environmental effects ranged from minimal to nonexistent. No serious problems were identified. Limited studies by other groups have added to our current knowledge and generally indicated the same results.

- Significant information has been developed regarding the fate and transport of various compounds. Results of the studies of ten existing systems, referenced above, indicate that the soil had a very large capacity for retaining most metals and for preventing their migration to groundwater. The transport of neutral organic compounds to groundwater has also been studied and a model has been developed and verified for their behavior in land application systems. (C. Enfield, submitted to the Water Resources Bulletin.) This interactive computerized model is being used by OPTS to evaluate the relative hazard to groundwater contamination by chemical (pesticide) application to the land. The model is being frequently used on the Office of Pesticide Program's chemical registration and recall process.
- Models have been developed for predicting the movement and retention of nitrogen and phosphorus. To describe pollutant transport, knowledge of water flow is required. A numerical simulation model has been developed and verified with laboratory and field data under transient conditions for both water and chemical transport. The model has the advantage over previous models in stability and accuracy of the projection. The solution is obtained in one step rather than the more conventional approach separating the saturated and unsaturated flow aspects. The model addresses drainage requirements for slow-rate and rapid-infiltration wastewater treatment sytems which are currently needed by design engineers.

Several papers describing these modeling efforts have been submitted for publication:

- Enfield, Carl, "Methods of Approximating Transport of Organic Pollutants to Groundwater," submitted to Water Resources Bulletin.
- Enfield, Carl, and John Wilson, "Transport and Fate of Selected Organic Pollutants in a Sandy Soil," submitted to Journal of Environmental Quality.
- Enfield, Carl, "Comparison of a 1-Dimensional, Steady State Hydraulic Model with a 2-Dimensional Transient Hydraulic Model for Aldicarb Transport through Soil," Proceedings, Groundwater Quality International Symposium, Amsterdam.

A "Summary of Long-Term Rapid Infiltration System Studies" (EPA 600/2-80-165) condensed and made the results of studies of four operating rapid infiltration systems readily available. A major contribution of this report was the presentation of a new design rationale for rapid infiltration systems based on water quality requirements.

The first National Seminar on Overland Flow Technology for Municipal Wastewater, sponsored by EPA, presented the current state-of-the-art for design and operation of overland flow systems. Due to the growing interest in the use of overland flow systems and the meager published information for their design, this seminar was very timely and beneficial. Proceedings are being published.

4.6.3 Current Research Plan

The research plan for land application of wastewater, represented by Table 4.5a, is relatively unchanged from the 1980 strategy. Several milestones have been completed, as indicated, and some future milestones have been extended. Milestone completion dates which have been extended include the Lubbock demonstration project, assessment of long-term effects from six slow-rate systems and development of the nitrogen management model. No new sub-objectives have been added; however, some have been expanded and additional milestones added.

In order to respond to increased Agency emphasis on the use of natural treatment systems, the Municipal Wastewater Research Committee recommends the adoption of a new initiative in the area of land application of wastewater and aquaculture. The new research effort would focus on the development of natural systems for wastewater treatment including land application, the use of wetlands and aquaculture. Cost of the effort is expected to be about $1 million per year beginning in 1982 with three additional positions.

The Committee also recommends that the Land Treatment Task Force at RSKERL be continued after September 30, 1981, and serve on a national basis rather than serving only Regions VI and VII. If continued and expanded, the Task Force responsibilities should encompass all natural systems including land treatment, aquaculture and wetlands.

4.6.4 ORD Response to Agency Research Requirements

Research needs of the operating programs, as presented by the Program and the Regional Offices, fall into four categories: an understanding of the fate and transport of pollutants, particularly nitrate, sodium, heavy metals and organics, through soils; the development and refinement of design and operating criteria for all types of land treatment systems, especially overland flow in northern climates; the establishment of the long-term environmental effects of land treatment systems; and the development of preapplication treatment criteria, including the need for disinfection. Two Program Offices and four Regional Offices have requested research in the area of land application of wastewater. Additionally, there are many needs in the area of land application of sludge. A list of 19 needs grouped into four categories is shown below:

Fate and Transport of Pollutants through Soils

a. Ecological studies of land application - OWPO(M)
b. Water reuse after land treatment: pathogen and other constraints - OWPO(L)
c. Groundwater impacts of toxics - OWRS(H)
d. Fate of nitrates, sodium and trace metals - Region I(H)
e. Lateral and vertical transport of pollutants - Region I(H)
f. Safe distances from water supplies - Region I(H)
g. Nutrient retention in fast percolation lake soils - Region I(M)
h. Effect of wastewater injection on groundwater - Region II(M)

Design and Operating Criteria

i. Update design, performances and long-term effects information - OWPO(M)
j. Determine slope/residence time for overland flow - OWPO(M)
k. Evapotranspiration systems: design criteria and costs - Region I(H)
l. Design data from overland flow in northern climates - Region V(H)
m. Safe land application practices for the western U.S. - Region VIII(H)
n. Effect of rainfall on pathogens - OWPO(L)

Long Term Environmental Effects

o. Finalize and publish state-of-the-art health assessment and undertake followup studies - OWPO(H)
p. Health risks due to food chain transfer of toxics or pathogens - OWPO(L)
q. Sampling methods at aquifer interfaces - Region I(H)

Preapplication Treatment Criteria

r. Pathogen die-off rates in holding ponds - OWPO(M)
s. Pretreatment and disinfection guides for land application - Region VIII(H)

Much has been learned about the design and operating requirements of the three types of land application systems. Criteria for slow rate systems are well established, but will require refinement as experience is accumulated. The design of rapid infiltration systems is fairly well developed but management practices need to be devised to maximize the treatment capability of the soil while protecting the groundwater. Design criteria for overland flow systems in southern climates are generally reliable, but information on specific operating conditions and effectivness of treatment of certain pollutants is lacking. There is a high degree of interest within the construction grants program for utilizing overland flow. Thus far, the use of the overland flow process is confined to the milder southern tier of states. This past year, the first EPA project to develop the overland flow process in severe northern climates was initiated.

Work is well under way to develop a management system for protecting groundwater from nitrate buildup under land application systems. A study of the behavior of organics was initiated last year and a model, being used currently by the OPP, has been developed and verified for selected organics.

Considering available resources, the Committee believes that the present effort in the area of fate and transport is adequate and is addressing many of the needs. Additional resources however would allow a desirable acceleration of the effort relative to studies of toxics and organics.

New projects related to the development and refinement of design and operating criteria are restricted to the overland flow process. With existing and projected resources, funds are not available for demonstration projects or additional evaluation studies. Therefore, this information will have to come from other sources and the few existing projects that have not yet been completed.

Limited work has been done regarding preapplication treatment requirements for land treatment. The ten existing systems studies referred to above represented systems using different preapplication treatment processes. The effects of the preapplication treatment, however, were given limited analysis. Results of several studies on various preapplication treatments for overland flow systems show that in general, treatment efficiency decreased with higher degrees of pretreatment. Primary treatment appears to be the optimum. Preapplication treatment by lagoon results in low suspended solids removal. Overland flow is evidently not too effective in removing suspended solids in the form of algae. No work has been done on requirements or effects of disinfection prior to land application.

Because of limited resources, very limited data will be produced relative to preapplication treatment criteria. Under current plans, existing and future projects will provide some data but without funds to initiate projects specifically for this purpose, development in this area will be extremely slow. Studies of disinfection requirements are not currently planned.

Because of limited resources, no additional new work is planned to evaluate long-term environmental effects of preapplication treatment.

The growing interest in land application systems and their funding through the construction grants program is a clear indication that research in this area should keep pace with the operating program's needs. Current and projected funding levels for land application research are inadequate. There is little prospect of significant new starts in this research area without substantial increases in the base budget or the funding of new initiatives.

Several needs (f, g, h, k, n, q and r) are not being addressed specifically by this land application research group, while others (n and r) are being addressed to some degree by the U.S. Army Corps of Engineers at Vicksburg, MS or Hanover, NH.

LEGEND:

▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

Table 4.5a

SCHEDULE OF R&D OUTPUTS

Land Application of Wastewater

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
LAND TREATMENT																																						
1. Land treatment task force report																																						
a. Interim progress report						▲																																
b. Final evaluation report											△																											
2. Summary report on existing slow-rate systems							△	—	—	△																												
3. Lubbock demonstration of slow-rate irrigation																																						
a. Complete construction						△	—	—	—	△																												
b. Research reports												△	—	△				△	—	△																		
c. Final project report																									△	—	—	—	—	—	—	—	△					
4. Summary report rapid infiltration systems			▲																																			
5. Overland flow design and operating criteria																																						
a. Effects of pretreatment										△																												
b. Effect of retention time on treatment performance												△																										
c. Performance when receiving lagoon effluent													△																									
d. Final criteria including northern climates																														△								
6. Rapid infiltration design and operating criteria																																						
a. Revised design criteria			▲																																			
b. Design criteria for environmentally controlled systems																														△								
7. Develop design and operation criteria of slow rate systems																																						

*Projects that could be completed with funding above FY81 level.

LEGEND:

▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

Table 4.5a

SCHEDULE OF R&D OUTPUTS

Land Application of Wastewater

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
a. Evaluate crop selection for nitrogen uptake																								△														
8. Develop model for P-soil reactions and kinetics																																						
a. Calcareous soils							▲																															
b. Acid soils																								△														
9. Nitrogen management model for rapid infiltration																																						
a. Interim report													△																									
b. Final model																			△	—	—	—	—	—	△													
10. Soil transport and transformation of toxic substances																																						
a. Reports on toxic substance/soil interaction							▲						△						△						△													
b. Predictive models									▲		△																										△	
11. Case studies of ten land treatment systems				▲																																		
12. Land treatment design manual													△																								△	

* Projects that could be completed with funding above FY81 level.

4.6.5 Research Program Description and Objectives of Aquaculture

The 1972 Water Pollution Control Act (PL 92-500) and the 1977 amendments clearly give impetus to the development and use of aquaculture treatment of municipal wastewater. Due to treatment effectiveness and the potential for cost and energy savings, aquacultural processes are being considered as favored alternatives to conventional wastewater treatment facilities by at least 40 municipalities in the United States.

Because of the growing interest in using aquaculture processes for wastewater treatment and management, wastewater aquaculture is a viable research area having large potential for application. Wastewater aquaculture is very broad in scope, involving a variety of organisms, both freshwater and marine environments, organized treatment processes and wastewater recycling by inputs into natural aquatic habitats. The technology is in its infancy and therefore, in order to develop processes for wastewater treatment or reuse, it is necessary to evaluate a variety of parameters to establish reliable design and operating criteria.

Two factors must be considered in assessing the value of these processes: the role of aquaculture in the overall management of municipal wastewater; and progress toward developing design criteria for operational systems.

A recent engineering assessment of aquacultural wastewater treatment concludes that aquatic plant systems using water hyacinth and wetlands systems have a potential for pollutant removal that can equal or may exceed that of mechanical treatment systems. It is expected that developed aquacultural processes will be preceded by conventional secondary treatment with current emphasis being nutrient removal and polishing treated effluents. In some instances, consideration is being given to treatment of conventional primary effluents. Additional research is needed for development of new aquacultural processes to treat municipal wastewater as well as for refinement of existing processes. As new processes are developed, pretreatment requirements will need to be established in order to effectively position the aquacultural component within the overall treatment or management system.

Aquaculture research is directed toward the development of natural systems for the treatment and management of wastewaters. Aquatic organisms or habitats of interest include natural and man-made wetlands, vascular plants, invertebrates finfish, shell fish and various combinations thereof. Emphasis has been placed on development of these biological/ecological systems as polishing units following primary or secondary treatment, for use in upgrading lagoons and, in some cases, as complete treatment systems. The research approach is two fold: exploratory research to identify promising systems; and developmental research for those systems having the most potential for early utilization and payoff. Consideration is given to economic factors, potential resource recovery and reuse, potential for valuable product production and possible energy conservation.

4.6.6 Recent Research Accomplishments

The aquaculture research program is in its infancy and budgeted resources have been relatively small. Nevertheless, several significant accomplishments have been achieved. The most noteworthy are the following:

- Experiments involving silver carp and bighead carp (exotic filter feeding finfish) have been highly successful. Results indicate that aquaculture has good potential for application in the treatment of municipal wastewater. At present, several communities are considering application of this type of process as an innovative technology system under the construction grants program. Under experimental conditions, an annual fish production rate of 6,000 pounds per acre was achieved. During FY80, health effects studies were initiated to determine the feasibility of a variety of uses for the large amounts of fish produced. These studies are being conducted cooperatively with HERL and are concentrating on enteroviruses and pathogenic bacteria.
- Preliminary evaluation of a water hyacinth system receiving conventional primary treated municipal wastewater indicates that 80 to 90 percent removals of BOD_5 and total suspended solids were achieved at a hydraulic loading rate of 1 mgd per 14 acres.
- EPA co-sponsored a seminar on Aquaculture Systems for Wastewater Treatment at Davis, CA. An engineering assessment prepared as a result of the seminar concluded that aquatic plant processes as well as wetlands processes have good potential for municipal wastewater treatment applications. Proceedings of the seminar and the engineering assessment have been published (EPA 400/9-80-006).

4.6.7 Current Research Plan

The research plan for wastewater aquaculture is presented in Table 4.5b. Several limitations of the present plan, due largely to resource constraints, can be noted. Among these are the fact that little data will be obtained on removal of priority pollutants by aquaculture treatment nor will macrophytes other than water hyacinths be extensively investigated. Finally, it appears that research will concentrate on artificial wetlands as opposed to natural wetlands. It is anticipated that the maturing of the research effort will allow its extension into these key areas. The aquaculture research effort would be broadened significantly by the natural systems' initiative described earlier in this section.

4.6.8 ORD Response to Agency Research Requirements

Few research requirements directed explicitly at wastewater aquaculture were listed in Chapter III although it should be noted that most of the general land treatment requirements also apply to aquaculture systems as well. The shortage of expressed research needs is understandable inasmuch as the concept of wastewater aquaculture is of very recent origin.

The specific aquaculture needs listed relate to long-term environmental effects, and the development of design and operating criteria for various natural systems including wetlands, water hyacinths and polyculture systems.

Studies of long-term environmental effects cannot be approached by studying existing systems as was done in land application studies, for there are no existing systems with long operating histories. Data on these effects must be accumulated over time as new systems are put into operation and mature. By using modeling techniques, it is possible that predictions of future effects can be made. This possibility will be investigated as systems for study become available.

Practically all of the current efforts in the program are directed to developing design and operating criteria for various aquatic systems. Projects are active in the development of water hyacinth systems, wetlands processes and finfish systems. Preliminary results from some projects, as indicated above, look very promising. None of the projects, however, have been completed. Projects for developing design and operating data for the most promising systems will be given high priority.

Table 4.5b

SCHEDULE OF R&D OUTPUTS

Aquaculture and Wetlands

LEGEND:

- ▲ Completed Project Outputs
- △ Proposed Project Outputs
- — Estimated Project Period

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
AQUACULTURE AND WETLANDS																																						
1. Evaluate use of fish species in wastewater treatment																																						
a. Assessment of indigenous species						△																																
b. Assessment of exotic species										△	—	△																										
2. Evaluate water hyacinths for treating primary and secondary effluent																																						
a. Preliminary design criteria												△																										
b. Evaluation of environmental control units																		△																				
c. Evaluation of hyacinth harvesting and utilization																		△	—	—	—	—	—	—	△													
d. Full-scale demonstration (9/86)																																				△		
3. Evaluate artificial and natural wetlands																																						
a. Annual interim reports												△						△						△														
b. Wetland assessments																														△	—	—	—	—	—	△		
4. Evaluation of other higher plants																																						
a. Report on nutrient film technique																△																						
b. Report on exploratory studies of several aquatic species																						△																
c. Interim reports on process development																												△						△				
d. Establish preliminary design criteria (9/86)																																						
5. Technology transfer																																		△				

* Projects that could be completed with funding above FY81 level.

4.7 URBAN RUNOFF RESEARCH

4.7.1 Research Program Description and Objectives

The control of urban stormwater runoff and combined sewer overflows (CSO) is an important element for the attainment of the goals of water quality legislation. Sections 201 and 212 of the Water Pollution Control Act for example, placed remedial facilities for control of pollution from combined sewer overflows and urban stormwater runoff on an equal footing with sewage treatment works in the authorization of grants for, and definitions of, treatment works. Section 211 of the Clean Water Act Amendments, however, disallows any grants through FY82 for treatment works specifically for the control of pollutant discharges from separate storm sewer systems. Also, construction grant funding policy emphasizes the secondary treatment of dry weather flows more than combined sewer overflows. Nevertheless, urban wet weather discharges continue to be important to R&D planning because of the strong national need. The 1978 Needs Survey indicated needs for CSO control at $26 billion; tentative figures from the 1980 Needs Survey show a sizeable increase over that figure. However, the R&D funds for stormwater runoff have steadily declined in recent years due to higher Agency priorities and the overall reduction of research funds.

In response to legislation and Agency needs, the urban runoff research effort presently has three major objectives:

- Pollution Problem Assessment. Part of this objective is to characterize urban wet weather discharges and to develop correlations between effects found in receiving waters, type of receiving water and quantity of discharges. A recently added concern is the consideration of toxics. The development of management and user assistance tools such as residuals handling methods; guidelines and user manuals for wet weather measuring and sampling; statistical methods for quality and quantity predictions; and cost-effectiveness determinations are also included in this objective.
- CSO Pollution Management. The principal activity under this objective has been the development of cost effective technology for CSO pollution control. Approaches have included storage/sedimentation, dual use (wet/dry weather) facilities and high rate single use facilities. Emphasis is presently in dual use technology which can sustain short periods of high flow. Efforts related to control of

infiltration and inflow (I/I) into sanitary sewers is included under this objective. Because of the magnitude of this problem and high Agency priority, a substantial part of program resources is presently devoted to I/I control.

- Stormwater Pollution Control. Although construction grants are not presently given for control of discharges from storm sewers, there is still Agency concern over stormwater pollution control. Work in this area is directed toward the development and evaluation of best management practices (BMP's) and other remedial measures including the use of wetlands from runoff control. The results support the Nationwide Urban Runoff Program (NURP) and the Clean Lakes Program.

4.7.2 Recent Research Accomplishments

For the past several years, an increased emphasis has been placed on pollution problem assessment. A number of receiving water impact studies were conducted in an attempt to determine more clearly what detrimental effects can result from urban runoff discharges.

Most of the information on receiving water impacts has been summarized in "Urban Stormwater and Combined Sewer Overflow Impact on Receiving Water Bodies: Proceedings of National Conference" (EPA-600/9-80-056). Studies of dissolved oxygen (DO) and sediment/benthic effects dominated recent problem assessment activities. A study in Milwaukee (EPA-600/2-79-155) identified sediment oxygen demand from CSO contaminated sediments as the principle mechanism for DO depletion, particularly during disturbed hydraulic conditions. This same mechanism is now considered to be operative in many locations where water velocities are usually low and are only increased significantly during storms. An analysis of continuous water quality monitoring sites in and downstream of urban areas suggests that direct DO depletion due to urban wet weather sources is not as severe as previously thought (EPA-600/2-79-156). In urban wet weather discharges, pathogens (indicator organisms) can often be shown to interfere with recreational use of receiving waters. It is likely that this impact is more widespread than realized because of the failure of many communities to measure indicator organism levels after storms. The two DO studies mentioned above, indicate an important departure from traditional DO considerations, relating to urban wet weather sources, sediment transport, deposition and oxygen demand, particularly for CSO which have high volatile settleable solids. Biological and sediment/benthic effects were investigated for separate stormwater systems in Coyote Creek (EPA-600/2-80-111). Both studies showed a decline in the quality of receiving water, but the decline was difficult to interpret clearly with respect to the decline in beneficial use of the waters. A model for determining the movement of CSO sediments has been developed (EPA-600/2-80-126) and a users guide (EPA-600/8-80-048) was developed for evaluating the impact and abatement of CSO on receiving waters based on studies of Onondaga Lake.

Much information on CSO control methods and studies is available in convenient form in the documents "Urban Stormwater Management and Technology, An Assessment" (EPA-670/2-74-040) and "Urban Stormwater Management and Technology, Update and User's Guide" (EPA-600/8-77-014). A recent significant accomplishment was the demonstration of the effectiveness of sewer flushing of dry weather deposits (EPA-600/2-79-133 and EPA-600/2-80-118). Sewer flushing was shown to be effective for reducing solids and associated contaminants and, if combined with in-line storage, to reduce the cost of CSO control facilities. However, the perception that sewer flushing technology is not fully proven will be held by the engineering community until full-scale prototype systems are demonstrated.

The most significant recent accomplishment, with regard to pollution from separate storm sewers, was the completion of an evaluation of street cleaning under real world conditions in San Jose (EPA-600/2-79-161). This study has become the prototype for the various NURP projects that are evaluating street cleaning under other climatic, geographic and urban conditions. In San Jose, a tenfold cost increase over typical street cleaning would be necessary for substantial improvements in urban runoff water quality. With intensive street cleaning (once per day), total solids and heavy metal yields were reduced up to 50 percent; organics and nutrient yields reduction, however, was less than 10 percent. These results clearly caution against assigning any significance to street cleaning for urban runoff pollution control. In a Boston study of runoff pollutant removal via catch basins (report in preparation), COD, BOD and solids reduction was quite effective if these units were cleaned frequently. The first phase of a study of the use of porous pavement and similar alternatives for runoff control in Austin, Texas has been completed (EPA-600/2-80-135). Existing design, instructional and operational data on existing porous pavement areas were summarized.

A general summary of the research accomplishments for FY80 in the area of Urban Runoff is given below:

- Final Reports
  -New Materials (Concrete Pipe Impregnation)
  -Porous Pavement (Design & Operational Criteria)
  -Case Histories
  -Receiving Water Impacts (University of Central Florida Proceedings; Sutron; Atlanta; University of Florida; Lake Washington)
  -CSO Treatment Technology (Screening/Flotation)
  -BMP Evaluations (Woodlands, TX; Street Cleaning; Sewer Flushing)
  -Biological Effects of Urban Runoff (Coyote Creek)
  -Planning Model for Urban Runoff Control (QQS; Stormwater Management Rec Water Level III)
  -Stormwater Runoff Management for New Residential Developments
  -Methodology for Evaluation Impact/Abatement of CSO's
- Pollution Problem Assessment
  -Toxicity Data Gathering (in conjunction with Region II & OWRS)
- CSO/Stormwater Pollution Control
  -Infiltration/Inflow (Coordination with OWPO)
- Technical Assistance and Technology Transfer (Approximately 1 man-year)
  -Consultation to Federal, State, Local Governments and Quasi-government agencies
  -Public Information Request
  -Consultation to Foreign Governments
  -In-House Seminars
  -Stormwater Management Model (SWMM)
  -Higher Education
  -Planning/Design/SOTA/Assessment/Manuals/Extramural Publications
  -Extramural Journal and Magazine Publications

4.7.3 Current Research Plan

Pollution problem assessment. Ongoing problem assessment projects include development of matrices of causes and effects leading to logical control requirements and characterization of toxics. Ongoing and planned areas of study are shown in Table 4.6. Substantial increase in support or toxics evaluation occurred in FY81 through cooperative funding with OWRS. Detailed evaluation of the oxygen demand rate of CSO sediments also began in FY81. The sediment oxygen demand work will receive additional support in FY82.

Needs relating to both problem assessment and the effectiveness of combined sewer control approaches could be met by obtaining data from full-scale plants. This would provide more dependable information than could be obtained in any other way. A survey of possible sites has been undertaken and evaluation of an appropriate facility is planned for FY82. Support of this type of project is seen as a continuing function of the program for several years.

CSO pollution management. Recently, emphasis on research for CSO control technology has been placed on the evaluation of methods having the potential for dual use application. These studies are being conducted in conjunction with the process development program. Existing studies involve ultraviolet disinfection, magnetic separation and fluidized bed reactors. Resource requirements for I/I control will limit additional studies, but some provision will be made to evaluate promising new dual use technology, e.g., anaerobic treatment or inlake storage, which improves the cost effectiveness for storing and treating CSO at existing plants. Results will become available from the feasibility evaluation of Insituform, a new technology for I/I control. Development of an improved I/I evaluation methodology and an improved method for rehabilitating service laterals, begun in FY81, will continue in FY82. Additional technical studies and consideration of institutional problems are expected to follow but will not begin until preliminary results become available from ongoing work. As indicated under research for pollution problem assessment above, initiation of a study of a full-scale CSO facility is planned for FY82. A CSO design manual is also planned for FY82.

Stormwater pollution control. Projects dealing with a number of BMPs, including porous pavement and wetlands, are ongoing. No new studies of stormwater control measures at Lake Eola in Florida are planned for FY82. The evaluation would take advantage of remedial measures constructed by the Clean Lakes Program. To be of maximum value, the compendium of BMPs shown in Table 4.6 item

3.d., should include results from projects funded by the NURP program. Funding reductions will extend beyond the FY82 completion date for this compendium.

Since separate storm sewer discharges are generally viewed as less polluting than CSO, and are being investigated extensively by NURP, research priorities must logically favor CSO control. Within the current resource levels, only very limited support of stormwater-related work appears possible in the foreseeable future.

4.7.4 ORD Response to Agency Research Requirements

In the area of urban runoff, a total of 35 research requirements have been stated by the Program and Regional Offices; about two-thirds of these are not duplicative. Organized under several separable categories, these needs and the related research activities are described below.

Pollution problem assessment. Three Program Offices and four Regional Offices have expressed needs dealing with pollution sources, impacts and the special nature of storm events:

a. Data analysis and tools for wet weather problems - OWE (H)
b. Areawide evaluation of urban complexes for runoff problems and solution; short- and long-term impacts of runoff - OWRS (H), OWPO (M), Region II (M)
c. Cooperative effort to quantify and compare pollutant sources and impacts - OWRS (H), OWE (H)
d. Effect of toxics in urban runoff on stream biology - OWRS (H)
e. Data collection on storm events - Region IV (H), Region VII (L)
f. Effect of atmospheric deposition - OWRS (H)
g. Data for wet weather flow criteria and standards - OWRS (H), Region I (H)
h. Effect of runoff on water quality - OWRS (L)

The initial series of impact projects recently completed (Table 4.6) have provided useful information and pointed out the need for certain additional studies. To date, results on various aspects of dissolved oxygen and pathogen impacts have been obtained. An ongoing evaluation of DO effects on the Scioto River, a project to develop matrices of receiving waters and types of impacts, and a small inhouse effort to define criteria for the degree of CSO control constitute the last effort in the foreseeable future dealing with the general area of problem assessment. A significant cooperative effort with OWRS, funded in FY81, along with limited earlier work, is expected to provide data for the characterization of toxics in urban runoff. A project to be funded in FY81 and FY82 will respond to the need for data on sediment oxygen demand and whether sediment oxygen demand is of sufficient magnitude to limit the attainment of water quality goals with or without CSO controls.

Atmospheric deposition has been considered only as it relates to street sweeping. A few NURP projects do include collection of wet and dry fallout. Other needs (a and g) are not being addressed by the projects discussed above or listed in Table 4.6; these fall under the auspices of the Water Quality Committee.

CSO pollution management. Because of the confusion that arises with the use of the term urban runoff, it is difficult, in some cases, to determine whether specific needs relate to CSO or stormwater. In the category of combined sewer overflows, three Program Offices and Region I have expressed needs dealing with hardware-oriented and management-oriented control technologies, along with their impacts on water quality and economics. These needs include:

a. CSO controls, evaluations, and methods of evaluating their impact - OWPO (H, M)
b. Design manual on available CSO control - OWPO (H)
c. Verification of approach and results for CSOs in 40-city study - OWE (M)
d. Evaluate effectiveness of conventional controls - OWRS (H)
e. Demonstrate sewer flushing on large sewers - Region I (H)
f. Demonstrate microscreening with high-rate disinfection - Region I (H)
g. Innovative ways to optimize the size and operations of CSO facilities; cost effective CSO controls - Region I (H), OWE (M)
h. Technical support on 201 CSO projects - Region I (M)
i. I/I evaluation, remediation and technology transfer - OWPO (H, M), Region X (H)

In addition to the stormwater management users' guides and reports on sewer flushing, screening and disinfection, manuals on swirl technology and storage/settling are being completed. Evaluations of several other technologies are listed in Table 4.6 It appears, however, that a single volume CSO technology design manual would be useful. Preparation of a concise design manual will be given high priority for funding in FY82.

The program has maintained a continuing low to moderate effort in the area of I/I control and has produced a number of user-oriented reports. Discussion with OWPO during FY80 led to the outlining of an expanded I/I program. Beginning in FY81, a significantly increased effort was begun to find ways of overcoming I/I problems, especially those from service laterals. A project was also started to develop a better methodology for use by municipalities in estimating the cost of remediation. These projects will require up to one-half of the total FY82 program resources for completion. Although transfer of I/I technology would be of some value now, desired developments would greatly increase the usefulness in about two years.

Toxic materials in a small number of CSO samples have been characterized and more will be included in the previously mentioned cooperative toxics project with OWRS. Some data on removal of toxics from CSOs entering existing biological treatment plants will be obtained from a 25-city survey being conducted under the toxics program. In addition, there will be results from the 40-city survey being conducted by OWRS for CSO sampling occurring during periods of rain. Assuming no significant hydraulic loading increase over design conditions, CSO removals should be essentially the same as those for dry weather conditions. Extrapolating from results observed during treatment for dry weather flows, it is very unlikely that the operation of biological treatment processes would be affected to a significant degree by CSO. Some heavy metals removal data are available for most CSO control technologies. No specific additional toxic studies to determine removals for other than biological CSO control methods are being considered because of budget limitations.

With regard to regional technical assistance, the program has always attempted to fulfill all requests; the staff will continue to provide this technical assistance, as time permits.

The needs not specifically met by the CSO research program include c, e and f in the above list.

Stormwater pollution control and other needs. Wet weather criteria, Best Management Practices (BMP), toxic impacts and material balances are needs stated for this category:

a. Develop separate storm sewer wet weather pathogen criteria - OWPO (H), OWRS (H), Region V (H)
b. BMPs: assessment criteria, economic impacts, effectiveness - OWE (H), OWRS (M)
c. Re-examine wet weather criteria for salmonella - OWPO/NURP (H)
d. Toxic exposure/response curves for time variant systems - OWPO/NURP (H)
e. Data for material balances of toxic and other compounds - OWRS (H), OPTS (H)

Program resource limitations and current agency priorities prevent extensive new work on stormwater pollution control. Completed and ongoing projects provide performance and cost data on a range of BMPs including street sweeping, use of catch basins for pollutant removal, wetlands, porous pavement, flow attenuation and upstream storage. No new toxic related work is planned, although some stormwaters previously have been characterized for metals.

Although no program effort is planned with regard to indicator organisms, HERL has completed a very lengthy evaluation of the relationship of indicator organisms in ocean waters to the incidence of disease at beaches (EPA-600/1-80-031). Specific pollution sources were not evaluated, only the mixture resulting in the ocean from these sources. Recognizing this limitation, the HERL results still constitute the best available information. Similar information is presently being gathered for freshwater beaches.

Some of the Agency needs are not specifically related to the above categories. Several mention storm data collection, but give no detail. One deals with health risk assessment. None of these are being addressed and will not be addressed because of a lack of resources. There is an existing rainfall-runoff data base that might be helpful to those needing stormwater data (EPA-600/8-79-004).

Specific needs not addressed include c and d in the above list. These two needs are related to the Water Quality Research Committee activities.

LEGEND:

▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

Table 4.6

SCHEDULE OF R&D OUTPUTS

Urban Runoff

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
1. Pollution Problem Assessment																																						
a. Studies of sediment impacts and benthic effects including sediment oxygen demand				▲														△	—	—	△																	
b. Symposium on receiving water impacts from urban stormwater	▲																																					
c. Nationwide assessment of receiving water impacts	▲																																					
d. Matrices of causes and effects of urban runoff						△	—	—	△		△	—	△																									
e. Movement and effects of CSO sediments in receiving waters				▲																																		
f. Impacts of full-scale facilities																									△						△							
g. CSO control requirements based on water quality impacts												△																										
h. Assessment of toxic effect of urban runoff													△						△																			
2. CSO Pollution Management																																						
a. Planning and design principles for urban runoff control facilities				▲										△																								
b. Storage/sedimentation design manual													△	—	△																							
c. Stormwater evaluation methodology and flow monitoring manual													△																									
d. Assessment of ultraviolet disinfection																			△																			
e. Demonstration of high gradient magnetic separation													△																									
f. Demonstration of fluidized bed reactors																					△																	
g. Demonstration of new dualuse technology																									△													
h. Evaluate new I/I control technology													△																									

*Projects that could be completed with funding above FY81 level.

LEGEND:
▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

Table 4.6

SCHEDULE OF R&D OUTPUTS

Urban Runoff

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
i. Develop standardized methodology to evaluate I/I problems																△																						
j. Develop improved methods for service lateral rehabilitation																						△												△				
k. Great Lakes Program cooperative projects (various outputs)																																						
l. CSO design manual																									△													
3. Stormwater Pollution Control																																						
a. Evaluation of eutrophic lake restoration						△	—	—	△																													
b. Compendium of urban wetland utilization											△																											
c. Document on secondary considerations in urban runoff pollution abatement											△	—	△																									
d. Compendium of BMPs for urban runoff pollution control																△	—	—	—	—	△																	
e. Demonstration of swirl, helical bend and teacup concentrator/regulators																			△																			
f. Needs survey support (various outputs)																																						
g. Section 208 (NURP) support (various outputs)																																						

*Projects that could be completed with funding above FY81 level.

4.8 ENERGY RESEARCH

4.8.1 Research Program Description and Objectives

The Clean Water Act of 1977 (PL 95-217) requires EPA to emphasize energy conservation and recovery in the treatment of municipal wastes. Section 201 of the Act encourages the adoption of waste treatment management methods, processes and techniques that reduce total energy requirements. It also encourages facilities to use waste heat and thermal discharges. Section 202 provides financial incentives to municipalities receiving construction grant funds to use treatment processes and techniques which use energy conservation. These financial incentives are provided to municipalities which adopt technologies that achieve a 20 percent net primary energy reduction over conventional alternatives. Financial incentives are also provided to municipalities which design and construct facilities to help achieve the national goal of increased energy recovery, conservation, reuse, and recycling.

The energy conservation research program was developed by the Wastewater Research Division and serves as a useful planning guide for initiating energy-related research, however, there are no current funds budgeted for a separate energy research program. Most of the accomplishments and energy-related activities were carried out as integrated study components of ongoing research programs such as innovative and alternative technology, sludge management and improved plant operations. This program could serve as the focal point for several Agency-wide efforts. It could also provide technical assistance to other research laboratories and to the Regional and Program Offices and could assist and undertake joint projects of mutual interest with other Federal agencies. A Memorandum of Understanding between the U.S. Department of Energy's Office of Conservation and Solar Energy and EPA's Office of Water and Waste Management has been proposed for a cooperative effort in the areas of energy conservation and resource recovery in municipal wastewater treatment. Unfortunately, funds are no longer available for this joint effort.

The national energy requirements in the year 2000 have been estimated to exceed 100 x 10^{15} Btu/year. Although the fraction of national demand attributed to municipal wastewater treatment is rather small (0.3%), efforts are being made to realize energy savings in this sector because, locally, such savings will be significant. Perhaps two-thirds of energy use for municipal treatment could be eliminated via conservation efforts. Such savings would exceed the total energy requirements for a city of one-half million.

The overall program objective is directed towards energy savings derived through more efficient design and operation of municipal wastewater treatment facilities. It is not directed at energy production from non-municipal wastewater sources (i.e., anaerobic digestion of agricultural biomass).

The near-term objectives are to identify, optimize and encourage the acceptance and implementation of low or no-cost energy processes and systems for mainstream wastewater and sludge treatment and disposal.

The long-term objectives are to develop, demonstrate and encourage the implementation of new technologies, modifications of existing processes, and the integration of innovative concepts into municipal wastewater collection and treatment systems, including the use of alternative energy sources.

4.8.2 Recent Research Accomplishments

As FY80 was the first year in which an energy conservation research and development program was implemented for municipal wastewater, accomplishments and outputs reflect the division's long-standing interest in the area. These accomplishments have been documented in other program areas, notably the programs involving Innovative and Alternative Technology, Plant Operation and Design and Municipal Sludge Management.

Most of the past information related to engineering assessments and field evaluations on plant operations has been conducted to establish baseline energy performance data by the Plant Operation and Design and Municipal Sludge Management Programs. Emphasis in these studies is directed towards evaluations of energy efficiencies in conventional unit process systems for wastewater treatment and sludge handling and disposal operations. For example, a summary of the energy consumption characteristics in treatment facilities was reported in August 1978 - "Total Energy Consumption in Municipal Wastewater Treatment," (EPA 600/2-78-149). This comprehensive study provides a baseline to gauge the areas where improved efficiencies in operations and equipment should be directed. Another important study, "Computer-Aided Synthesis of Wastewater Treatment and Sludge Disposal Systems" (EPA 600/2-79-158), December 1979, allows the design engineer to rapidly select, through interactive modeling techniques, equipment and treatment systems as a function of operational energy requirements. Focus has also been placed on developing information documents to assist planners, designers and managers in making energy comparisons and to provide guidance in the identification and quantification of energy recovery and reuse opportunities. An output of this area is represented by the March 1978 report entitled, "Energy Conservation in Municipal Wastewater Treatment" (EPA 430/9-77-011). Outputs also include a series of technology assessment manuals that provide energy information for a wide range of state-of-the-art processes including solar applications, vertical tube chemical reactor and anaerobic treatment.

Other research accomplishments specific to plant operation and design and to municipal sludge management are described in previous sections.

4.8.3 Current Research Plan

ORD energy conservation research activities and planned outputs are categorized by three general objectives: to identify and develop energy-effective mainstream processes and systems; to develop and optimize energy conservation and generation in municipal sludge treatment and disposal systems; and to evaluate, develop and optimize the use of alternative energy sources for wastewater collection and treatment systems. The scope of activities includes on-site engineering and systems analysis, pilot plant development, and construction and operation of full-scale waste treatment facilities. As this R&D program serves as the Agency's focal point for energy conservation activities, it will overlap or provide plan implementation input for other organizational divisions with joint participation, including other agencies, state and local governments and industry.

To meet near-term objectives, current activities in the energy conservation R&D program (Table 4.7) include the following:

- Design, construction and field evaluation of a vertical tube reactor system for municipal sludge treatment
- Engineering and field evaluation studies to review and analyze energy conservation measures in wastewater treatment technologies with a focus on recommendations to improve energy-effective design
- Engineering and cost-analysis studies to identify and assess electric power generation opportunities at municipal wastewater treatment facilities

4.8.4 ORD Response to Agency Research Requirements

In the area of energy conservation, a total of eight research requirements have been identified by the Program and Regional Offices. Of this total, about five are non-duplicative. Organized under several separable categories, these needs are discussed below.

Energy conservation (EC) requirements. Energy conservation requirements focus on the need to identify effective operating procedures and equipment that reduce energy consumption in mainstream processing. The requirements listed are:

a. Methods to reduce energy consumption at POTWs - Region I(H)
b. Energy reduction techniques for high energy components of treatment - OWPO(H)
c. Energy conservation, recovery and production studies - OWPO(H), Region VIII(H)
d. Natural systems for energy use reduction - OWPO(M)

Energy production (EP) requirements. Because sludge represents a source of organic material which can provide a net energy gain at treatment facilities, production studies focusing on sludge are required by the Program and Regional Offices. The requirements are:

a. Evaluation of the potential for energy production, recovery and use-

Region VIII(H), OWPO(H)

b. Thermal conversion, digestion, and methane recovery/cleanup from sludge and hardware development - OWPO(M)

Energy-related innovative (EI) application. Because energy recovery, whether from sludge or waste heat, will require advancements in the state-of-the-art, certain requirements focus on these innovative developments. These include:

a. Beneficial reuse/recycle of sludge and wastewater for biomass production - OWPO(H)
b. Methane recovery from sludge through hardware development for thermal conversion and anaerobic digestion - OWPO(M)

Table 4.7 presents the energy conservation R&D objectives and outputs. All of these objectives are expected to meet the needs discussed above.

Some of the previously described accomplishments have provided baseline data for energy requirements of selected wastewater treatment processes and sludge disposal. Similar information for both conventional processes and newer technologies has been published in the Innovative and Alternative Technology Assessment Manual. This work partially satisfies some of the objectives for EC requirements a, b, c and EP requirement a above. Some of the energy-related for sludge (EP, requirement a) are concerned with the process only, and are considered in the Municipal Sludge Management Program. EC requirement a, is concerned with the overall energy efficiency of POTWs. This concern will be addressed in the plant operation and design program by a study of POTW energy conservation. The results of this study will be reported in a manual as part of the Design Information Series.

Because there is a continuing need in all areas for information on recent technological advances in wastewater treatment, four 40-60 page draft reports have been completed. The documents contain the status of development, a detailed technical evaluation, cost and energy benefits, technology limitations and an assessment of the potential national impact. The four completed assessments are solar applications in wastewater treatment, Vertical Tube Chemical Reactor (VTCR), fine bubble diffusers and anaerobic treatment of wastewater. Additional technology reports are to be initiated in the near future and will include alternative energy sources and all on-site energy generation prospects including heat pumps and windmills, deep shaft, anaerobic digestion of combined wastes, aquaculture and wetlands. Future research needs which include energy conservation and recovery systems, will be updated annually.

In order to satisfy stated needs of the Program and Regional Offices, the following integrated studies will be performed in conjunction with ongoing research programs:

- Engineering and field evaluation studies of the energy conservation effectiveness of wastewater treatment technologies and equipment and recommendations to improve the design of systems and equipment
- Evaluation of total building and treatment systems energy requirements and the identification and qualification of all energy recovery and reuse opportunities
- Engineering and cost analysis of electric power generation from all sources in wastewater collection and treatment systems including residuals management
- Field evaluation and process performance monitoring of the vertical tube reactor system for the treatment of municipal sludge
- Evaluation of conventional and new sludge treatment and disposal technologies with respect to energy effectiveness, and the identification of potential high risk, second generation energy reducing concepts and equipment

Table 4.7

SCHEDULE OF R&D OUTPUTS
Energy

LEGEND:
▲ Completed Project Outputs
△ Proposed Project Outputs
— Estimated Project Period

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
1. Conduct energy conservation analysis studies to identify and develop most energy effective mainstream processing																																						
a. Complete energy conservation and recovery sensitivity analysis					△																																	
b. Begin engineering and field studies to demonstrate 3 most energy effective technologies																△						△						△										
c. Finish all work and disseminate results																																					△	
2. Conduct studies to identify, develop and optimize energy conservation and generation for municipal sludge treatment and disposal processes																																						
a. Award grant to design and construct major energy conservation facility													△																									
b. Complete energy conservation project																												△										
c. Identify additional energy conservation recovery projects																			△																			
3. Conduct studies to identify, develop and optimize the use of alternative energy sources for wastewater treatment and collection. Includes solar, heat pumps, hydro biogas and on-site electric generation																																						
a. Complete on-site electric power generation survey report																						△																
b. Complete on-site alternative energy generation summary report																															△							

✱ Projects that could be completed with funding above FY81 level.

4.9 SMALL WASTEWATER FLOWS RESEARCH

4.9.1 Research Program Description and Objectives

The research efforts for small wastewater flows (SWF) have historically dealt with evaluation of alternative wastewater technologies, concentrating on on-site treatment and disposal, alternative wastewater collection systems and septic tank pumpings (septage) treatment and disposal. In order to maintain advances made in each of these areas, it became evident within the past few years that significant efforts were necessary in related areas such as management arrangements, improved technology impact, implementation programs and other complementary areas. The outputs of the program have been geared to the needs of Federal, state, and local regulatory agencies, consulting engineers, planners and private sector individuals dealing with these technologies.

In light of the above, the present program can be divided into the following categories:

- Implementation of SWF technology
- Treatment technology evaluation
- Appropriate 21st Century technology development
- Non-residential and specialized rural wastewater system development

The level of activity in each of these categories has varied over the past few years. As noted above, the technology evaluation work has been equalled or surpassed by the implementation efforts, as measured by resources expended. The 21st Century and specialized wastewater work has been modest.

4.9.2 Recent Research Accomplishments

During FY80, major accomplishments included the publication of the OWPO/-MERL/CERI Onsite Systems Design Manual and six other final reports on the topics of septage management, alternative on-site systems evaluation, sources of toxic compounds in household wastewater and comprehensive facility planning for small communities. Additional accomplishments included major technical assistance efforts, initiation of the Cincinnati Center for Small Community Wastewater Systems Studies, and the takeover of responsibility for the EPA Small Wastewater Flows Clearinghouse.

The above accomplishments and other program activities have provided further insight into future program direction. Clearly, the justification for 21st Century technology development has been weakened through the rather negative findings of nearly completed research and lack of support from program client communities. Conversely, the need to provide additional efforts toward SWF technology implementaton goals has been clearly noted, both through the enormous demand for the Onsite Manual and by other more direct inputs from client communities. The type of effort demanded appears to be one balanced between direct implementation efforts and indirectly through alternative technology information production.

4.9.3 Current Research Plan

In order to implement the SWF research program necessary to satisfy the needs submitted by OSW, OWPO and the Regional Offices, it has become necessary to develop arrangements to maximize the limited resources available to the program. The three arrangements developed to accomplish this are the SWF Clearinghouse, the Cincinnati Center, and a Level of Effort (LOE) contract. The Clearinghouse provides literature searching and communications with the user community and assumes some of the technical assistance burden. The Cincinnati Center will provide a more directly controlled study of viable alternative technologies and a showcase of alternative systems in one area. Both entities will directly affect environmental engineering education by incorporating small flow technology into their associated universities' curricula. The LOE contract will permit the performance of the necessary research studies to satisfy the needs of the Agency and the user community which would otherwise be delayed by several years due to the limitations on resources and flexibility.

The SWF research program planned outputs are described in Table 4.8.

In order to answer the specific OWPO research requirements pertaining to evaluation of data obtainable from existing 201 projects, there are certain factors which must be considered. In the base program outlined above, the approach is designed to deal with technologies, e.g., SDG sewers, large SASs, pressure distribution systems, etc., with collection of easily obtainable information from 201 projects which have incorporated them for each technology studied. Although this approach will accomplish the goals of OWPO more slowly, it takes advantage of the fact that little data would be available from ongoing 201 projects at this time. As these projects are completed, field evaluation teams can evaluate them to determine detailed information on design, construction and O&M or management aspects of the technologies. Since insufficient resources are available in the base SWF Program to accomplish these in-depth studies, a new initiative which requires $1,000,000 and one additional staff position starting in FY83 is proposed. Such an effort would maximize the data obtainable from the current 201 projects in time for incorporation into the Advanced Collection Handbook and the updated Onsite Systems Manual.

In order to satisfy the research requirements for improved design and management approaches for onsite and small community wastewater systems, a second initiative is proposed which would anticipate and seek to obviate major O&M problems with these systems through the use of remote sensing, satellite plant circuit-riding concepts, design improvements to minimize labor costs and a variety of other techniques uniquely applicable to decentralized operations. This effort would be carried out in cooperation with the Plant Operation and Design staff in Cincinnati and would seek to identify the most critical O&M problems, analyze their functional roles with respect to design and operation, and develop and test alternative systems and components which might minimize or eliminate these problems. In order to accomplish this, an above-baseline initiative of $400 to 500 K for two years and one additional staff position would be required.

4.9.4 ORD Response to Agency Research Requirements

The following is a list of research needs expressed by the Program and

Regional Offices in the area of small wastewater flows:

a. Characterize contaminants in septic tank pumpings and effect of disposal practices - OSW(M)
b. Provide increased technical assistance - OWPO(H)
c. Evaluate projects using current design information - OWPO(H)
d. Complete septage manual - OWPO(H), Region I(H), Region II(H)
e. Compile state-of-the-art summary of large subsurface drainfields - OWPO(M)
f. Improve cost, design, performance and reliability information - OWPO(M)
g. Develop facility maintenance and impact monitoring methods - OWPO(M)
h. Evaluate low-pressure subsurface soil distribution and small subsurface aerobic systems - OWPO(L)
i. Compare costs of gravity sewers vs. alternative systems - OWPO(L)
j. Develop methods to predict life of leaching fields - Region I(H)
k. Develop control options for acid-lime side-streams from septage pretreatment - Region I(H)
l. Evaluate lagoon, septic tank seepage for coastal soils - Region IV(H)
m. Determine effects on wetland water quality - Region IV(M)
n. Determine cost-effectiveness and benefits of BMPs - Region V(H)
o. Determine efficacy of dual septic tanks in series - Region V(M)
p. Effects on wetland productivity; other options - Region VI(M)
q. Develop alternative control technologies - Region VII(H)
r. Develop data on small-scale treatment technology - Region IX(H)

These research requirements reflect the discussion under accomplishments, i.e., the major demands are for technology evaluation and implementation efforts by the SWF research program. In subdividing these categories, a more illustrative pattern can be determined.

Facility planning. Research requirements on this topic, which include site characterization, physical data assembly, and cost-effective analyses, were provided by OWPO and Regions I, V, and IX. A FY80 research report (EPA 600/8-80-030) and draft Environmental Impact Statments from Region V indicate that, although present methodologies are useful, the cost of a thorough facility plan could be prohibitive to a small community. Consequently, several field and modelling techniques show potential for reducing the cost and improving the equity of problem determination. A definitive study of these techniques and a review and analysis of total (capital and O&M) costs began in FY81 and will provide the necessary information to partially satisfy the above research requirements. More complete satisfaction will result when projects addressing technology evaluation and management issues have been completed and analyzed (approximately FY84 at present funding levels). Complete satisfaction within this time will require a special initiative, as discussed previously.

Management. Research requirements on this topic, which include management arrangements, septage/residuals handling and O&M requirements, were provided by OWPO and Region I. The Septage Handbook will partially satisfy these needs which were primarily directed toward more useful information on this subject. Additionally, the completion of the ongoing User's Guide on Management of SAWS (Small and alternative wastewater systems) and the OWPO and other 208 management initiatives will provide a sound basis for evaluation of actual management needs in FY83. Resulting management research requirements are anticipated to be satisfied by the special initiative referenced above and another dealing with O&M of SAWS, both of which have been described previously.

Health and environmental impacts. Research requirements on this topic were submitted by OSW and Region IV. Completion of ongoing studies on pollutant transport through soils below absorption beds will provide partial satisfaction to those needs with regard to nutrients and toxic organics. Health impacts have been initially addressed for certain onsite alternatives and will be pursued, pending the result of the upcoming conference on microbial health risks. These projects should satisfy the above requirements by early FY85. All work is being conducted in cooperation with RSKERL and HERL.

Technology implementation documents. Research requirements for specific program output documents have been provided by OWPO and Regions I and II. In order to provide useful outputs SWF has cooperated with OWPO and CERI. The most recent result has been the Onsite Manual. Present efforts are directed toward the Septage Handbook and a User's Guide for Management of SAWS. In FY82, an Advanced Collection Systems Handbook will be initiated, to be followed by a revision of the Onsite Manual. These outputs should satisfy the expressed research needs, although the specific OWPO requirements for an Onsite Alternatives Manual will be incorporated into the revised Onsite Manual due to limited resource availability. The SWF Clearinghouse will be a useful entity in communicating with the user community and fostering interest in the program products.

Technical assistance. OWPO was the only office to submit a research requirement for technical assistance (TA). Since this area has heretofore drained significant manpower from the SWF staff, appropriate cutbacks in TA are anticipated. Therefore, TA will be limited to 75 person-days per year with priority given to OWPO requests.

Treatment technology evaluation. Under the major topic of technology evaluation, subtopics include a variety of onsite and centralized collection and treatment system study areas. However, since the majority of the submitted research requirements were generally addressed to the development of performance, design, cost and reliability of alternative and conventional rural wastewater systems, this major research topic will not be subdivided in the same manner as technology implementation.

Research requirements promoting the continued evaluation of alternative technologies, both onsite and community-wide, were submitted by OWPO and Regions V and VII. A series of field studies spanning FY81-83 and data gathered by the Cincinnati Center for Small Community Wastewater Systems Research will provide needed data to partially satisfy these requirements. Available data from these and other sources will be incorporated into the updated Onsite Manual in FY85 and the Advanced Collection Systems Handbook in FY84.

Specific research requirements were submitted for the following topics:

- Evaluation of pressure distribution systems (OWPO)
- Evaluation of large soil absorption systems (OWPO)
- Evaluation of dual septic tanks in series (OWPO)

A field study project initiated in FY81 will satisfy the pressure distribution system requirement by obtaining and analyzing data from North Carolina (Carlisle system), Wisconsin (SSWMP system) and other locations. Similarly, a FY81 project will gather analytical data on large SASs from Washington, Wisconsin and New England.

Needs expressed by the Regional Offices which are not met by the current research plan are l, m, o and p in the above list of requirements.

Table 4.8

SCHEDULE OF R&D OUTPUTS
Small Wastewater Flows

LEGEND:

▲	Completed Project Outputs
△	Proposed Project Outputs
—	Estimated Project Period

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
1. Implementation of SF technology																																						
a. Improved facility planning						▲												△								△												
b. Optimum management strategies						▲						△																		△								
c. Health and other environmental impacts												△												△														
d. Technology transfer documents						△											△															△						
e. Technical assistance, up to 75 md of staff time						△						△						△						△						△						△		
2. On-site technology evaluations																																						
a. Land insufficiencies																								△														
b. Groundwater vulnerability																										△												
c. Severe water and climate with above also																				△															△			
3. Collection and treatment technology evaluations																																						
a. Low-cost collection systems																							△															
4. Appropriate technology for 21st century												△																										
5. Non-residential and specialized rural wastes																																						
a. Commercial establishments																								△												△		

* Projects that could be completed with funding above FY81 level.

4.10 INNOVATIVE AND ALTERNATIVE TECHNOLOGY RESEARCH

4.10.1 Research Program Description and Objectives

Enactment of the Clean Water Act (CWA) of 1977 provided major reorientation in EPA Programs to meet national water quality goals by the increased use of innovative and alternative (I/A) technologies. The I/A technology provisions of the CWA clearly establish intent to encourage the development and implementation of I/A technologies for the treatment of the nation's municipal wastewaters while advancing the state-of-the-art in wastewater treatment technology across a broad front. Taken together, Sections 201, 202 and 205 encourage the use of technologies which reclaim and reuse water, recycle wastewater constituents productively, conserve or recover energy, reduce capital and operating costs, improve operational reliability, improve toxics management, improve environmental benefits or provide for improved potential for joint municipal/industrial treatment. Special financial incentives are provided to municipalities to adopt use of I/A technologies including 10% grant increases 15% cost effectiveness preferences, fund reserves for grant increases, and 100% modification grants for failed facilities. Finally, Section 105(j) authorizes post-construction performance evaluations of I/A technology.

To carry out the mandates of the CWA, a high visibility I/A Technology Program was established at MERL. The I/A Technology program is a seven man-year effort and is divided into four areas of activity: the Technical Support Group (TSG); Information Dissemination; the I/A Technology Program; and the I/A Research Program.

The Technical Support Group reviews I/A facility plans and I/A designs submitted by the EPA regional offices, provides technical assistance to the regions and states, operates the I/A Clearinghouse, keeps track of progress of the I/A Program, evaluates results and provides policy review support to Washington.

Information dissemination includes activities such as preparation of manuals, articles, brochures, flyers and other similar documents intended to reach a wide range of audiences and conducting technical seminars and workshops for consultants, grantees and federal/state officials.

The Agency has initiated an Active I/A Technology Program in order to encourage greater use of I/A technologies and to generate more I/A projects. Efforts included in this area are intended to identify recently developed emerging I/A technologies and assist local communities and their consulting engineers with assessment and analysis of emerging technologies that may be applicable to their specific wastewater treatment control or management problems.

The I/A Research Program is a relatively new initiative including study of technologies which have high potential for cost and energy savings and other benefits. In order to avoid duplication of efforts, the I/A Research Program is conducted in partnership with other Wastewater Research Division entities: the Process Development Branch, Small Flows Program, and Energy Program in the Systems and Engineering Evaluation branch. As such, the I/A Program is a vital element of R&D, acting as a focal point or bridge between pure research and development activities and implementation of technology in the field. One purpose of the I/A Research Program is to identify and evaluate wastewater treatment technologies which show promise for reducing capital and operating costs and energy requirements. Evaluations include conduct of preliminary research engineering assessments of the potential of these promising technologies and of their stage of development. Feedback is provided to those responsible for process development and includes an identification of those technologies which have high potential for achieving cost and energy savings applicable to the Construction Grants Program. For a limited number of selected high potential technologies, the I/A Research Program provides the necessary funds to conduct research and demonstration studies in coordination with other programs in order to accelerate the design and development of emerging technologies.

Another purpose of the I/A Research Program is to ensure that these and related technologies are implemented as soon as possible through the Construction Grants Program.

In addition to the current I/A Technology Program, a new initiative has been conceptualized and will be initiated in FY82 to perform post-construction evaluations of I/A projects.

4.10.2 Recent Research Accomplishments

During FY80, the I/A program conducted over 100 technical reviews, developed over 20 active I/A projects completed four assessments on emerging technologies, and produced several manuals, brochures and workshops. I/A Clearinghouse Reports have been published quarterly since June 1979. The status of the I/A program described in these quarterly reports indicates that, in FY79 and FY80, 550 I/A projects have been funded. In addition, several presentations were made during the past year. "An Overview of EPA's I/A Technology Program" was presented at the 7th U.S./Japan Conference on Sewage Treatment Technology. "Progress in EPA's I/A Technology Program" was presented at the 7th National Conference on Individual On-Site Wastewater Systems and a presentation entitled "Innovative Municipal Energy Alternatives" was given to the Rocky Mountain sections of the American Water Works Association (AWWA) and the Water Pollution Control Federation (WPCF). The final version of the "I/A Technology Assessment Manual" was also published.

The Technical Support Group reviews covered 34 states and included risk/benefit analyses, costs and energy savings for the following technologies:

- VTR Chemical Oxidation
- Anaerobic Treatment
- Low Head Hydroelectric Power Generation
- Windmill Power Generation
- Improved Aeration Devices
- Dual Series Aerobic/Anaerobic Sludge Digestion
- Sequencing Batch Reactors
- Use of Small Individual and On-site Systems
- Ultraviolet Disinfection
- Aquaculture
- Land Treatment Systems

- Mechanical Composting
- Active/Passive Solar

Several draft reports dealing with emerging technology assessment have been completed and include solar applications vertical tube reactors and anaerobic treatment of wastewater. The active I/A Program provided assistance to 23 projects in seven Regions. Projects using particularly promising technologies are located in Montrose, Colorado and Hanover, New Hampshire.

4.10.3 Current Research Plan

The schedule of outputs planned for the I/A Technology Program is presented in Table 4.9; the Technical Support Group activities are listed under Tasks 2, 5a, b, and e. The resources presently allocated to this effort are sufficient to meet the key outputs listed. Also in Table 4.9: Information Dissemination is covered by Tasks 1, 4a, b, c, and d: the Active I/A Technology Program includes Tasks 4a, 5c, and d; and the I/A Research Program has outputs under Tasks 3a and 3b. Resource needs for these areas are discussed in the following section.

4.10.4 ORD Response to Agency Research Requirements

Two Program Offices and three regions have stated a total of 13 requirements:

a. Expand Active I/A effort for long-range improvements in technology efforts - OWPO (H)
b. Expand technology program transfer and conduct national symposia - OWPO (H), Region V (H)
c. Performance of I/A technologies on toxics (concentration and effects - OWRS (H)
d. Procedures for post-construction evaluations of energy savings - Region I (H)
e. Criteria for justifying 100% replacement - Region I (H)
f. Support I/A Clearinghouse - Region I (H)
g. Cost, performance and reliability data for I/A technologies - Region V (H)
h. Demonstration of vertical tube reactor - Region VIII (H)

i. Demonstration of wet oxidation of sludge - Region VIII (H)
J. Identify and support promising technologies - OWPO (M)
k. Emerging technology assessments - OWPO (M)
l. Regional and state project reviews - OWPO (M)
m. Detailed evaluations of selected I/A systems - OWPO (M)

All of the above requirements, except c and i, are being addressed directly by the research plan. Requirement c is addressed indirectly as part of Tasks 3a and 6 (Table 4.9)

In order to meet research requirement a, expansion of the Active I/A Program, an increase in resource commitment to R&D objective 5 (Table 4.9) is required. However, one limit to further success of the current Active I/A Program is a lack of adequate travel funds. In addition, a prerequisite of the current Active I/A Program was full-time regional EPA I/A coordinator support.

Requirements d and m are addressed by outputs 6a and 6d (Table 4.9) and outline a need to perform detailed post-construction evaluations of completed I/A projects which are in operation and which can be accomplished through Section 105(j) of the Clean Water Act and/or an independent ORD initiative. Section 105(j) addresses 100% grants to I/A grantees for evaluation of operation, training of personnel not employed by the grantee and information dissemination. Strict interpretation of 105(j) would require initiation of a small-scale grants program sponsored by ORD and coordinated with OWPO. However, 105(j) is ambiguous in several areas: I/A grantees may not desire grants to perform detailed evaluations of operations unless a problem already existed; EPA interest in training is during start-up and not during operation; training during start-up is already an eligible item under the Construction Grants Program; and, I/A grantees may not desire grants for information on successful I/A projects.

In order to pursue post-construction evaluations on the basis of 105(j), ambiguities need to be resolved. The best way to accomplish this is through a legislative initiative. An appropriation would also be required. Pursuit of I/A technology post-construction evaluations as part of an independent ORD initiative has several potential advantages. These include the ability to study selected projects in addition to those funded through the Construction Grants Program and the freedom to initiate action to perform evaluations rather than react to grant applications from I/A grantees. This new independent ORD initiative would require a new resource commitment. Preliminary estimated resources for this program are as follows: 1982, $2M, 2 positions; 1983, $4M, 4 positions; and 1984, $8M, 6 positions. Emerging technology assessments currently under development include the following technologies: deepshaft treatment, anaerobic digestion of combined wastes, aquaculture and wetlands. Future assessments are planned in the areas of:

- Co-Incineration
- Co-Pyrolysis
- Co-Starved Air Combustion
- Toxics Control Technology
- Carver Greenfield and Related Processes
- Sequencing Batch Reactors
- Thermophilic (Air + O_2) Sludge Digestion
- Mechanical Composting
- Energy Conservation and Recovery Systems
- Biological Nutrient Removal Processes

Requirement j (Identify and support promising technologies) is broad-based in nature and will be met by continuation of the I/A Research Program and the I/A Clearinghouse. However, in order to continue partial funding of projects initiated in FY81 and to fund new efforts in FY82, a significant increase in extramural funds will be necessary.

Table 4.9

SCHEDULE OF R&D OUTPUTS

Innovative/Alternative Technology

LEGEND:

▲ Completed Project Outputs

△ Proposed Project Outputs

— Estimated Project Period

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
1. I/A assessment manual	▲																																					
2. Operate I/A clearinghouse. Prepare 4 quarterly reports per year	▲						△						△						△						△						△							
3. Conduct I/A research to accelerate development of high potential technology																																						
a. For FY81 develop (award grant) a minimum of 3 long-term I/A research project in the area(s) of wastewater treatment, sludge management, toxics management													△																									
b. Identify second generation innovative projects to be funded in FY82 and 83																			△			△																
4. Conduct of I/A information dissemination program to educate and effect exchange between federal, state, local officials, consultants, equipment manufacturers, public interest groups																																						
a. For FY81 develop a series of at least 4 emerging technology assessments												△																										
b. Develop a series of quasi technical articles for public officials										△																												
c. Develop seminars, workshops as appropriate												△																										
d. Make presentations at conferences/professional meetings in at least 5 states												△																										
5. Provide technical/administrative assistance to regions, states, Washington																																						
a. For FY81 review all I/A applications as requested by regions within 15 working days													△																									
b. Provide technical assistance as requested. Provide detailed planning, design, construction													△																									

*Projects that could be completed with funding above FY81 level.

LEGEND:

- ▲ Completed Project Outputs
- △ Proposed Project Outputs
- — Estimated Project Period

Table 4.9

SCHEDULE OF R&D OUTPUTS

Innovative/Alternative Technology

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
c. Assistance on at least 15 identified active I/A projects												△																										
d. Identify a minimum of 3 high visibility active I/A projects											△																											
e. Provide OWPO, OWPS, OSW assistance in legislative initiatives, regulations policy guidance, technical assistance. Identify innovative wastewater treatment toxics and sludge management options													△																									
6. Post construction evaluations																																						
a. For FY81 develop plan, schedule and estimated budget										△																												
b. Develop a protocol for individual plant evaluations													△																									
c. Develop and describe test case study in FY82																			△																			
d. Implement full program FY83																									△													

*Projects that could be completed with funding above FY81 level.

4.11 HEALTH EFFECTS RESEARCH

4.11.1 Research Program Description and Objectives

ORD's health effects research responds to requirements of the Clean Water Act calling for the safe treatment, disposal and possible reuse of municipal wastewater and sludge and for the development of a health effects data base for setting water quality standards and effluent guidelines.

The health effects research program offers support to the Program Offices in three areas: wastewater and sludge management, reuse and recycling of wastewater and urban runoff. The major objectives of the program are:

- To determine the health implications of existing and innovative technology for the treatment and disposal of wastewater and sludge
- To develop a health effects data base to be used to formulate criteria for the safe reuse of wastewater for industrial, agricultural, and potentially potable purposes, and to assess the possible health impacts associated with reuse of renovated wastewater
- To determine the potential impact of combined sewer overflows and stormwater discharges on human health

4.11.2 Recent Research Accomplishments

Within the past two years a number of reports and papers relevant to the health effects of municipal wastewater treatment and reuse have been published and/or presented. Topics covered include wastewater aerosols, land treatment, land application of sludge, composting and renovated water. A list of these reports and papers is included at the end of this chapter.

4.11.3 Current Research Plan

The major program outputs planned for FY80-85 are shown in Table 4.10. Beyond these planned research efforts, four new research initiatives are suggested: health effects of the high-rate and application of sludge; health aspects of on-site wastewater treatment systems; health effects associated with wastewater aquaculture; and health significance of urban runoff.

Health effects of the high-rate land application of sludge. The disposal or use of municipal wastewater sludges through landfilling, land reclamation or high-rate application to agricultural land poses a potential threat to the underlying groundwater. This initiative will evaluate that threat with respect to pathogens (especially viruses), toxic organics and trace elements, and develop management methods to ensure goundwater protection. (FY83 funds - $300 K, 0 Positions)

Health aspects of on-site wastewater treatment systems. A considerable portion of the rural and suburban American population is served by on-site wastewater treatment systems, septic tanks with drain fields being of particular importance. This initiative will significantly increase resources to address the risk to public health posed by enteric pathogens contaminating the immediate area, surface water and groundwater. (FY83 funds - $300 K, 1 Position)

Health effects associated with wastewater aquaculture. The use of pretreated wastewater in commercial aquaculture is being considered as a means of using contained nutrients and decreasing pollutant discharges. This initiative will significantly increase resources to address the problem of ensuring that the products of wastewater aquaculture, i.e., fish and animal feed, do not create public health problems. (FY83 funds - $200 K, 0 Positions)

Health significance of urban runoff. Research efforts in the urban runoff area aim at relating the degree of treatment of point and non-point source discharges to health effects. Evaluation of the need for higher degrees of wastewater treatment to obtain reduced toxic organics or a virus-free effluent to prevent negative health effects in recreational waters of drinking water supplies is a focus, as is the development of better indicators of microbiological treatment efficiency. (FY83 funds - $500 K, 1 Position)

4.11.4 ORD Response to Agency Research Requirements

The majority of the needs expressed by Program and Regional Offices relate to the areas of land treatment, land application of sludge and urban runoff. All needs expressed are grouped by the major objectives of the wastewater health effects research program.

Land treatment of municipal wastewater. Epidemiological studies at land treatment sites in Texas and Israel are ongoing. The appraisal of the health effects of land treatment is near completion and will be revised as new information is available. Research on the fate of enteric pathogens during preapplication treatment, particularly in wastewater stabilization ponds (holding ponds, lagoons), has begun and will be expanded in the future. The fate of pathogens, especially viruses and parasites, in the soil matrix under various environmental conditions and the consequent entry into groundwater and the food chain continues to be studied. Since the health response of any particular dose of virus depends upon the minimum infective dose, research in this area continues. Research needs in this category include:

a. Finalize state-of-the-art health assessment for land application and start follow-up study - OWPO (H)
b. Pathogen die-off rates in land application holding ponds - OWPO (L)
c. Pathogen and other constraints to water reuse after land treatment - OWPO (L)
d. Health risks due to food chain transfer of pathogen or toxics during land treatment - OWPO (L)
e. Pretreatment and disinfection guides for land application - Region VIII (H)

Wastewater aquaculture. Although no specific research requirements were expressed in this area, the technical development of aquaculture systems is a medium-priority research area. The use of pretreated wastewater in commercial aquaculture is being considered as a means of using contained nutrients and decreasing pollutant discharges. The potential health hazards related to the practice and to the use of aquaculture products must be appraised.

Small wastewater flows. The technological development of on-site treatment systems is a medium-priority research area. Since a considerable portion of the rural and suburban American population is served by on-site wastewater treatment systems, particularly septic tanks with drain fields, the health effects resulting from these small systems will be evaluated in the future.

One high priority research need identified by Region IX is the requirement for treatment data on small-scale technology.

Land application of sludge. All the research requirements are addressed in the ongoing or planned sludge research program. Areas in this program include:

- Measurement and evaluation of the pathogen and chemical contamination hazards associated with land application of sludge
- Support studies on possible transmission of contaminants, including cadmium, microbiological agents and persistant organics, through the food chain
- Epidemiological studies on populations with exposure to sludge

Research needs in the area of land application of sludge include:

a. Fate and effects of toxics in CSOs and recycled wastewater and sludges - OWPO (H)
b. Pathogen die-off and risks in land application of sludge - OWPO (L)
c. Health risks due to food chain transfer of pathogens or toxics during land treatment - OWPO (L)
d. Pathogens in sludge: land application and disease correlation, studies of areas where sludge is applied to land - OSW (H)
e. PCB's in sludge: uptake by root crops, accumulation in livestock and milk-fat - OSW (H)
f. Lead in sludge: plant uptake studies, accumulation in soils - OSW (H)
g. Plant uptake of organics and trace metals (other than PCB, Cd, Pb) - OSW (M)
h. Epidemiological studies in sludge land application areas - OSW (M)
i. Compare current methods for dietary Cd exposure evaluation - OSW (M)
j. Effect of disposal practices - OSW (M)
k. Cd uptake by leafy plants, peanuts and fruits - OSW (L)
l. Fate of toxics from land-applied sludge - OPTS (M)
m. Environmentally acceptable sludge land spreading and landfilling methods - Region I (H)
n. Acceptability of landspreading and thermal destruction of urban area sludges - Region II (H)

o. Health implications of land treatment of wastewater sludges - Region IV (H)

p. Fate of viruses and pathogens in sewage sludge application - Region VII (H)

Other Sludge Treatment, Disposal and Utilization Practices. Sludge management is a high-priority research area. Most of the health effects research on sludge management is in land application, but other forms of sludge management, i.e., composting, drying and incineration, have considerable potential utility, particularly in urban areas. The health effects of these practices will be evaluated. A research need identified by Region II is:

- Acceptability of landspreading and thermal destruction of urban area sludges - Region II (H)

Reuse of municipal wastewater. ORD activities in the area of reuse and recycling of wastewater relate to a perceived future requirement to make the most efficient use of water resources and treatment capacity. This is to be accomplished by developing a data base for use in establishing criteria for the safe reuse of wastewater for industrial, agricultural and possibly potable purposes. Along with support data for criteria development are research activities in the areas of:

- Potential carcinogenic, organic constituents in effluents from advanced waste treatment systems
- Effects of treatment systems on the nature and toxicity of organic substances
- Toxicity testing procedures which may be applied to reuse situations
- Health risks of viruses occurring in the effluents
- Potential human health effects of groundwater aquifers recharged with treated effluents
- Health implications of non-potable reuse

Urban runoff and wastewater treatment. In the urban runoff area, there is a need to better understand and relate the treatment of point and non-point source discharges to health effects. Evaluation of the need for advanced wastewater treatment to obtain a relatively safe effluent to prevent adverse health effects in recreational waters is necessary, as well as better indicators of microbiological treatment efficiency. Research needs are:

a. Fate and effects of toxics in CSOs and recycled wastewater and sludges - OWPO (H)

b. Separate sewer wet weather discharge pathogen criteria - OWPO (M)

c. Urban runoff impacts and problem assessment - OWPO (M)

d. Effects of toxics in urban runoff-effect on biological integrity of stream - OWRS (H)

e. Data for wet weather flow criteria and standards-impact on POTW's and CSO's - OWRS (H)

f. Data for toxics material balances in urban runoff - OWRS (L)

g. Data for toxics material balances - OPTS (H)

h. Wet weather flow criteria assessment - Region V (H)

HEALTH EFFECTS RESEARCH REPORTS AND PAPERS

Wastewater Aerosols

Majeti, V.A., and C.S. Clark, "Potential Health Effects from Viable Emissions and Toxins Associated with Wastewater Treatment Plants and Land Application Sites." EPA-600/1-81-006, 1980.

Pahren, H.R., "Wastewater Aerosols Dnd disease." 53rd Annual Conference Water Pollution Control Federation, Las Vegas, 28 September-October 1980.

Pahren, H.R., and W. Jakubowski, ed., "Wastewater Aerosols and Disease." EPA-600/9-80-028, 1980.

Pahren, H.R., and W. Jakubowski, "Health Aspects of Wastewater Aerosols." Proceedings, Tenth International Conference, International Association on Water Pollution Research, Toronto, 23-27 June 1980.

Carnow, B., et al., "Health Effects of Aerosols Emitted from an Activated Sludge Plant." EPA-600/1-79-019. (Skokie, Illinois), 1979.

Johnson, D.E., et al. "Environmental Monitoring of a Wastewater Treatment Plant." EPA-600/1-79-027. (Tigard, Oregon), 1979.

Land Treatment

Johnson, D.E., et al., "The Evaluation of Microbiological Aerosols Associated with the Application of Wastewater to Land." EPA-600/1-80-015, 1980.

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Kowal, N.E., et al., "Microbiological Health Effects Associated with the use of Municipal Wastewater for Irrigation." International Conference on Cooperative Research Needs for the Renovation and Reuse of Municipal Wastewater in Agriculture, Mexico City, 15-19 December 1980.

Sagik, B.P., "Human Enteric Virus Survival in Soil Following Irrigation with Sewage Plant Effluents." EPA-600/1-80-004, 1980.

Clark, C.S., et al., "Evaluation of the Health Risks Associated with the Treatment and Disposal of Municipal Wastewater and Sludge." EPA-600/1-81-030, 1980.

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Yeager, J.G., "Risk to Animal Health from Pathogens in Municipal Sludge." In: "Sludge - Health Risks of Land Application" (G. Bitton et al., ed.), 173-199. Ann Arbor Science Pub., Ann Arbor, Mich., 1980.

Little, M.D., "Agents of Health Significance: Parasites." Ibid., 47-58.

Edds, G.T., et al., "Health Effects of Sewage Sludge for Plant Production or Direct Feeding to Cattle, Swine, Poultry or Animal Tissue to Mice." Ibid., 311-323. 1980.

Harding, H.J., et al., "Aerosols Generated by Liquid Sludge Application to Land." EPA-600/1-81-028, 1980.

Majeti, V.A., and C.S. Clark, "Potential Health Effects from Persistant Organics in Wastewater and Sludges Used for Land Application." EPA-600/1-80-025, 1980.

Kello, D., et al., "On the Role of Metallothionein in Cadmium Absorption by Rat Jejum in Situ." Toxicology 14:199-208, 1979.

Kowal, N.E., et al., "Normal Levels of Cadmium in Diet, Urine, Blood, and Tissues of Inhabitants of the United States." Journal Toxicology Environ. Health 5:995-1014, 1979.

Foulkes, E.C. 1980., "Some Determinants of Intestinal Cadmium Transport in the Rat." J. Environ. Path. Toxicol. 3:471-481, 1980.

Kowal, N.E., "Normal levels of Urinary Cadmium and Beta$_2$-Microglobulin in the United States." Third International Cadmium Conference, Miami, 3-5 February 1981.

Edds, G.T., and J.M. Davidson, "Sewage Sludge Viral and Pathogenic Agents in Soil-Plant-Animal Systems." EPA-600/1-81-026, 1981.

Beaudouin, J., et al., "Effects of Sewage Sludge Diets Fed Swine on Nutrient, Digestibility, Reproduction, Growth and Minerals in Tissues." J. Animal Science 50:572-580, 1980.

Bertrand, J.E., et al., "Effects of Dried Digested Sludge and Corn Grown on Soil Treated with Liquid Digested Sludge on Performance, Carcass Quality, and Tissue Residues in Beef Steers." J. Animal Science 50:35-40, 1980.

Bitton, G., et al., "On the Value of Soil Columns for Assessing the Transport Pattern of Viruses Through Soils: A Critical Outlook." Water, Air, and Soil Pollution 12:449-457, 1979.

Bitton, G.,et al., "Virus Detection in Soils: a Comparison of Four Recovery Methods." Can. Journal Microbiology 25:874-880, 1979.

Damron, B.L., et al., "Feeding Corn Fertilized with Municipal Sludge to Broiler Chicks and Laying Hens." Poultry Science 59:1561, 1980.

Johnson, W.L., and B.L. Damron, "Performance of White Leghorn Hens Fed Various Levels of Municipal Sludge or Selected Minerals." Poultry Science 59:1565, 1980.

Osuna, O., et al., "Feeding Trials of Dried Urban Sludge and the Equivalent Cadmium Level in Swine." Proc. 8th Natl. Conf. on Municipal Sludge Management, 201-213, 1979.

Composting

Clark C.S., et al., "Occupational Hazards Associated with Sludge Handling." In: "Sludge - Health Risks of Land Application" (G. Bitton et al., ed.), 215-244. Ann Arbor Science Pub., Ann Arbor, Mich., 1980.

Clark, C.S., et al., "Evaluation of the Health Risks Associated with the Treatment and Disposal of Municipal Wastewater and Sludge." EPA-600/1-81-030, 1981.

Renovated Water

Chappell, W.R., et al., "Health Effects of Consumption of Renovated Water: Chemistry and Cytotoxicity." EPA-600/1-79-014, 1979.

Reynolds, T.D., and S.J. Hawkins, "Water Treatment Project: Observations on the Use of GAC in Practice." EPA-600/1-80-023, 1980.

Chappell, W.R., et al., "The Effect of Ozonation of Organics in Wastewater." EPA-600/1-81-005, 1981.

Neal, M.W., et al., "Assessment of Mutagenic Potential of Mixtures of Organic Substances in Renovated Water." EPA-600/1-81-016, 1981.

McCarty, P.L., et al., "Mutagenic Activity and Chemical Characterization for the Palo Alto Wastewater Reclamation and Groundwater Injection Facility." EPA-600/1-81-029, 1981.

Saxena, J., and D.J. Schwartz, "Mutagens in Wastewater Renovated by Advanced Wastewater Treatment." Bull. Env. Contam. Toxicol. 22:319, 1979.

Wolf, H.W., et al., "Pyrogenic Activity of Carbon-Filtered Waters." EPA-600/1-79-009, 1979.

Jorgensen, J.., et al., "Comparison of Limulus Assay, Standard Plate Count and Total Coliform Count for Microbiological Assessment of Renovated Wastewater." Appl. Env. Microbiol. 37:928, 1979.

Pahren, H.R., and R.G. Melton, "Mutagenic Activity and Trace Organics in Concentrates from Advanced Wastewater Treatment Plant Effluent." In: "Water Reuse Symposium, AWWA Research Foundation," Denver, Colorado, 1979.

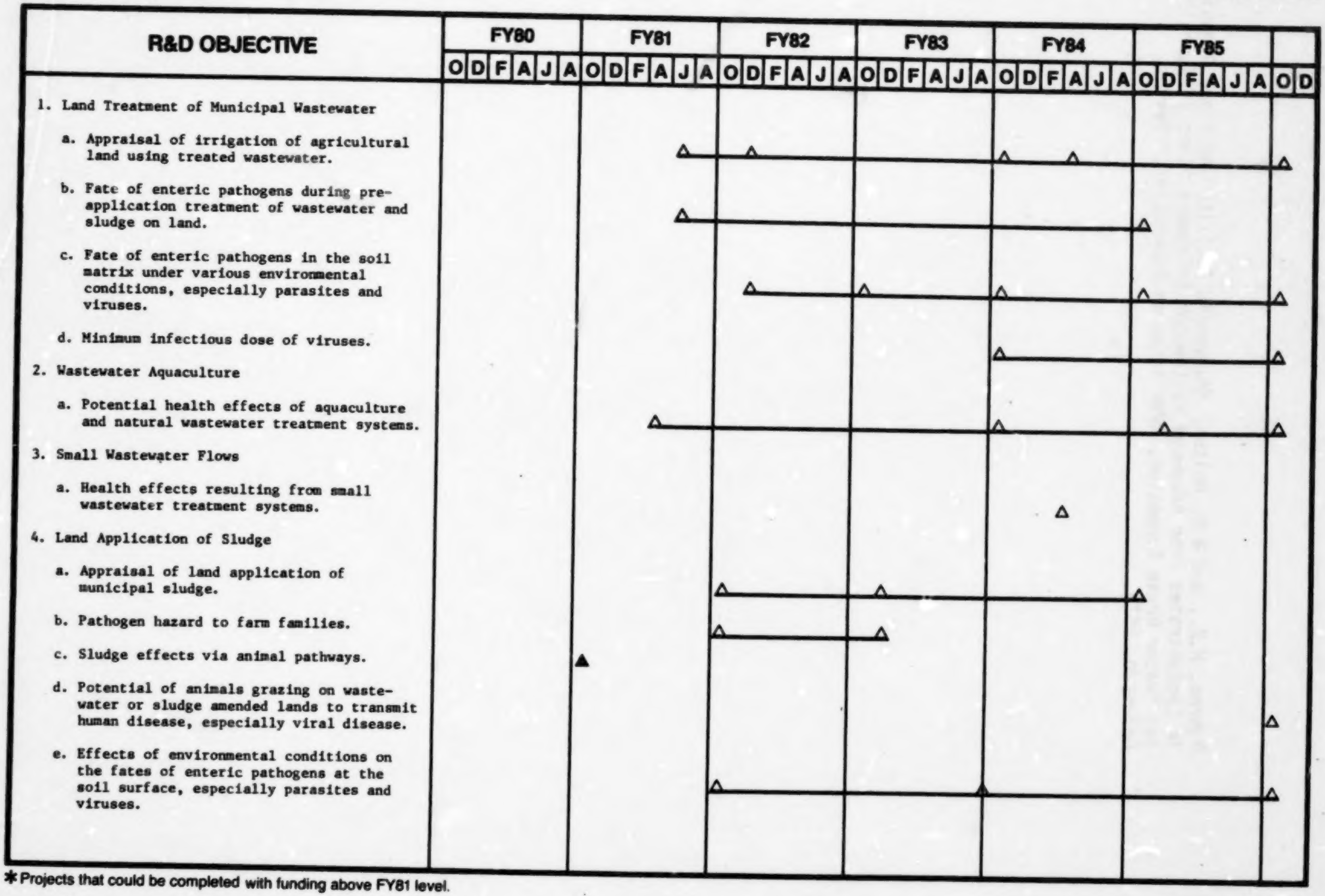
Table 4.10

SCHEDULE OF R&D OUTPUTS

Health Effects

LEGEND:

- ▲ Completed Project Outputs
- △ Proposed Project Outputs
- — Estimated Project Period



1. Land Treatment of Municipal Wastewater
   - a. Appraisal of irrigation of agricultural land using treated wastewater.
   - b. Fate of enteric pathogens during pre-application treatment of wastewater and sludge on land.
   - c. Fate of enteric pathogens in the soil matrix under various environmental conditions, especially parasites and viruses.
   - d. Minimum infectious dose of viruses.
2. Wastewater Aquaculture
   - a. Potential health effects of aquaculture and natural wastewater treatment systems.
3. Small Wastewater Flows
   - a. Health effects resulting from small wastewater treatment systems.
4. Land Application of Sludge
   - a. Appraisal of land application of municipal sludge.
   - b. Pathogen hazard to farm families.
   - c. Sludge effects via animal pathways.
   - d. Potential of animals grazing on wastewater or sludge amended lands to transmit human disease, especially viral disease.
   - e. Effects of environmental conditions on the fates of enteric pathogens at the soil surface, especially parasites and viruses.

* Projects that could be completed with funding above FY81 level.

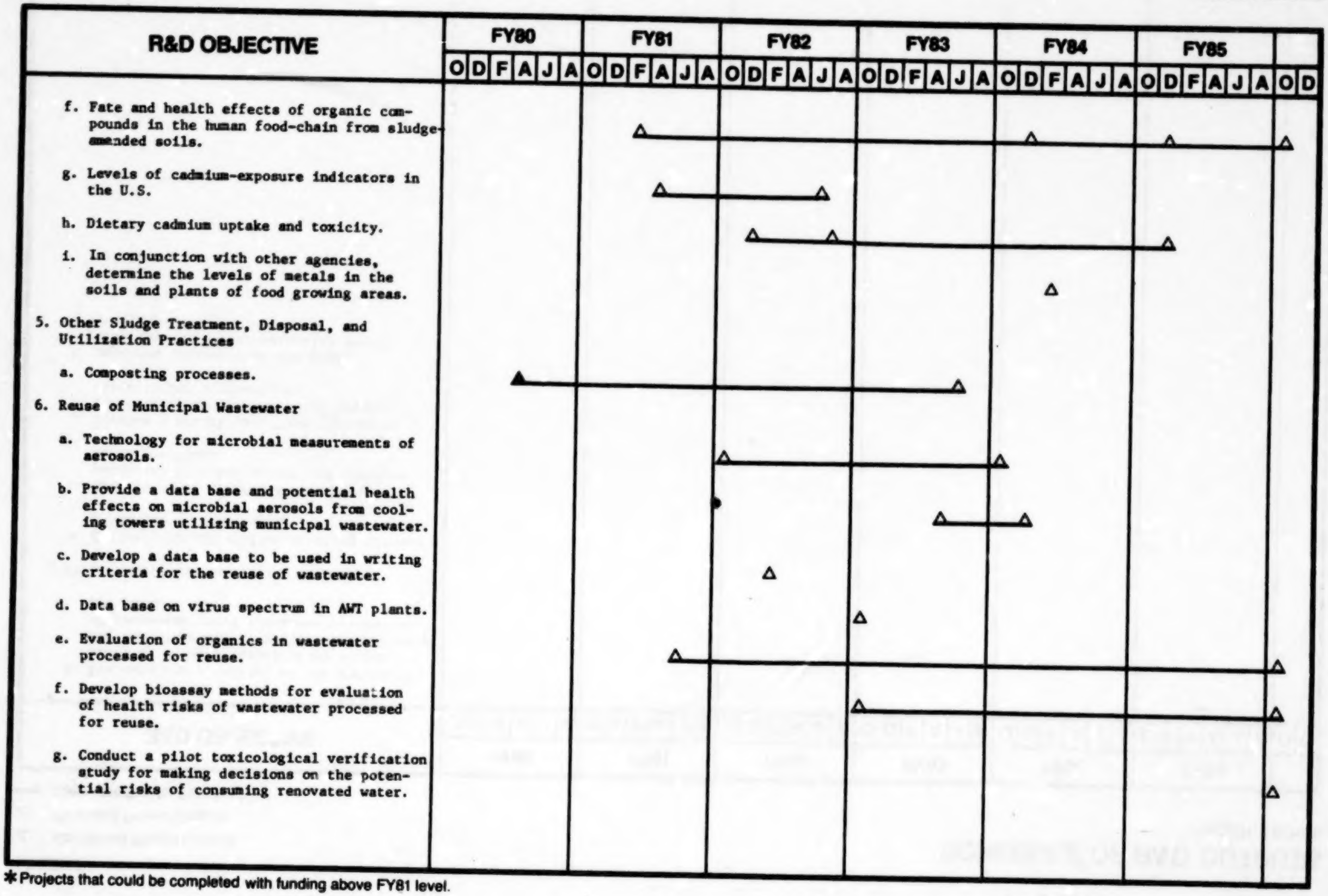
LEGEND:

- ▲ Completed Project Outputs
- △ Proposed Project Outputs
- — Estimated Project Period

Table 4.10

SCHEDULE OF R&D OUTPUTS

Health Effects



f. Fate and health effects of organic compounds in the human food-chain from sludge-amended soils.

g. Levels of cadmium-exposure indicators in the U.S.

h. Dietary cadmium uptake and toxicity.

i. In conjunction with other agencies, determine the levels of metals in the soils and plants of food growing areas.

5. Other Sludge Treatment, Disposal, and Utilization Practices

a. Composting processes.

6. Reuse of Municipal Wastewater

a. Technology for microbial measurements of aerosols.

b. Provide a data base and potential health effects on microbial aerosols from cooling towers utilizing municipal wastewater.

c. Develop a data base to be used in writing criteria for the reuse of wastewater.

d. Data base on virus spectrum in AWT plants.

e. Evaluation of organics in wastewater processed for reuse.

f. Develop bioassay methods for evaluation of health risks of wastewater processed for reuse.

g. Conduct a pilot toxicological verification study for making decisions on the potential risks of consuming renovated water.

* Projects that could be completed with funding above FY81 level.

Table 4.10

SCHEDULE OF R&D OUTPUTS

Health Effects

LEGEND:

▲ Completed Project Outputs

△ Proposed Project Outputs

— Estimated Project Period

R&D OBJECTIVE	FY80						FY81						FY82						FY83						FY84						FY85							
	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D
h. Evaluate the potential of the endotoxin assay as a rapid quantitative microbiological procedure to monitor the efficacy of renovated water treatment processes for potable use.																																					△	
7. Urban Runoff and Wastewater Treatment																																						
a. Epidemiological studies relating illness to degree of treatment.																															△							
b. Assessment of toxic and carcinogenic potential of urban runoff and combined sewer overflows.																																					△	
c. Develop a health data base supporting the development of microbial treatment criteria for stormwaters.																																					△	
d. Improved indicator of treatment efficiencies and/or potential health studies.																											△											

* Projects that could be completed with funding above FY81 level.

4.12 EXPLORATORY RESEARCH

4.12.1 Program Objectives

To achieve a reasonable balance between the immediate needs of the Agency and the general advancement of science through long-term activities, approximately 15 percent of the resources in the extramural research program have been set aside for long-term exploratory research. The objective of the grant program is to supplement ORD activities by stimulating scientific and technical research fundamental to pollution control advances. Specific program guidance will be given by the Research Committee for the solicitation of grant proposals on an annual basis.

Another supplement to the ORD program is the recent establishment of a number of innovative research centers at competitively selected universities. One of these centers is the Advanced Control Technology Research Center at the University of Illinois at Urbana. This program should provide a better link between basic and applied research within the Municipal Wastewater Research Program

4.12.2 Current and Proposed Exploratory Research Projects

The following subjects have been identified as having program interest for FY82:

- Assessment of the significance of bacterial regrowth in secondary effluent following disinfection with chlorine, ozone or ultraviolet light and the identification of the organism responsible for the regrowth
- Development of microorganisms with high phosphorus uptake capabilities by means of manipulating bacterial recombinant deoxyribonucleic acid (DNA)
- Development of an anerobic biodegradation test for organic compounds to screen for treatability of priority pollutants
- Development of means for measuring limits to composting through an evaluation of fundamental sludge constituents to aid in establishing valid design parameters

- Soil metal interaction - determine the interaction of, and the equilibrium state between, soil properties and the soluble/insoluble phases of metals
- Bioavailablity of cadmium - determine, through a fundamental study of cadmium chemistry and interactions with soils and crops, how to limit crop uptake of cadmium
- Development of an indicator-surrogate to simplify monitoring for the presence of toxic compounds
- Investigation of sorption and concentration of toxic organic compounds by municipal sludge
- Exploring the possibilities of genetically engineering microorganisms to increase their capacities to absorb nitrated and chlorinated organic compounes which have shown resistance to biodegradation
- Determining organic pollutants adsorption isotherms
- Developing a rapid screening test for determining the biogradability of priority pollutants in various soil types.

Current and continuing efforts at the Advanced Environment Control Technology Research Center are focused on the development of an understanding of the chemical, physical, and biological factors which limit the ability to apply control technologies. Current studies involve:

- Removal of trace quantities of organic matter from water by either biological or chemical means
- Analysis of the thermodynamic behavior of the supercritical extraction process
- Studies of the kinetics associated with the detoxification of fossil fuel combustion products
- Examination of surface properties and charge on the collection efficiency of aerosols
- Assessment of the research needs associated with physical and biological separation technology, chemical detoxification and thermal destruction of contaminants, transformation of sludge-borne heavy metals in soil, and genetic engineering as applied to environmental control

4.13 TECHNOLOGY TRANSFER

4.13.1 Objectives

The ultimate goal of the Municipal Watewater Research Program is to develop and provide up-to-date information on improved and new treatment processes and systems for the user community. For this reason, an essential part of the success of any research program is the effective transfer of information to the widest possible user audience.

Although this requirement is evident throughout the entire Municipal Wastewater Research Program, it is currently targeted as high priority in two Program research areas -- small wastewater flows and innovative and alternative technology. Technology transfer and information dissemination will also be greatly expanded in the areas of sludge management and plant operations and design.

A comprehensive list of planned technical information outputs is presented in Appendix B.

4.13.2 Small Wastewater Flows

This research area is designed to be responsive to the needs of the Regions, states and municipalities with state-of-the-art design and operating information. The bulk of this activity will be accomplished by two centers specializing in small wastewater flows information.

The first of these centers is the Small Wastewater Flows Clearinghouse at West Virginia University. The Clearinghouse provides the user community with literature searching services. It also disseminates and exchanges information and assumes the burden of technical assistance to those requesting such information.

The second of these centers is the Cincinnati Center for Small Community Wastewater Systems Research at the University of Cincinnati. The main purpose of the Cincinnati Center is to provide for field studies of viable alternative small wastewater flows technologies and to provide full documentation of the most successful alternative systems. The Center will also provide technical information and assistance to the Regions, states and municipalities.

4.13.3 Innovative and Alternative Technology

The objective of technology transfer in this research area is to address critical data gaps. Specifically, its aim is to accelerate the transfer of information on new cost-effective municipal treatment technology through the post-construction evaluation of I/A projects.

This is accomplished through EPA's I/A Technical Support Group which reviews facility plans and designs submitted by EPA Regional Offices; provides technical assistance to the states, Regions, municipalities, consultants and equipment manufacturers; operates the I/A Clearinghouse; tracks program progress and evaluates results; and provides policy review support to the Agency.

More specific planned technology transfer activities include the publication of manuals, new technology assessments, post-construction evaluations and other similar documents intended to reach the widest possible segment of the user community. In addition, a number of technical seminars and workshops are planned for I/A information transfer with consultants and Federal, state and municipal officials.

APPENDIX A

RESEARCH OR RELATED ACTIVITIES OF THE EPA OPERATING PROGRAMS, REGIONS AND OTHER FEDERAL AGENCIES

Several of the EPA offices outside of ORD conduct activities that are not considered to be research but do provide new problem-solving information. The National Urban Runoff Program (NURP), operated out of the Office of Water Program Operations (OWPO), is collecting data on urban non-point pollution in 25 cities throughout the nation. The objective of the study is to characterize the sources, pathways and amounts of priority pollutants entering receiving waters via runoff at various defined urban sites. The amount and significance of atmospheric deposition of priority pollutants is also being assessed from wet and dry weather monitoring data. Additionally, OWRS is conducting a Combined Sewer Toxic Study which will include sampling of combined sewers systems for priority pollutants during wet weather conditions.

OWPO and Region V are involved in some innovative approaches in the area of Small Wastewater Flows. New facility planning and management techniques are being tried in the field, including:

- OWPO
  - Co-sponsor National Sanitation Foundation Conference on Onsite Wastewater Systems
  - Field testing of management arrangements
  - Generic facility plan for small communities
  - Production of Onsite Wastewater Systems Management Guidance
  - 208 programs on management district development for onsite systems and financing arrangements for management programs
- Region V
  - 208 studies to develop and implement onsite and septage management programs at several locations
  - 201 projects incorporating new facility planning techniques of aerial photography, leachate detection, etc.
  - EIS projects assessing new facility planning techniques
  - 108 projects on water conservation effect on SASs, soil mapping through soil potential techniques and demonstration of several alternate onsite systems

Other Federal agencies also conduct research and related activities in the area of municipal wastewater control. These are described briefly below.

DEPARTMENT OF DEFENSE

Major groups concerned with wastewater research are:

Army

- Civil Engineering Research Laboratory (CERL), Champaign, IL
- Corps of Engineers (COE) Water Pollution Abatement Program (WPA) Office, Huntsville, AL
- The COE Cold Regions Research Laboratory in New Hampshire
- The COE Waterways Experiment Station in Vicksburg, MS
- Army Medical Research Group, Fort Dietrich, MD
- Army Hazardous Material Laboratory, Aberdeen, MD

Navy

- Navy Engineering Research Laboratory (NERL), Pt. Hueneme, CA

Air Force

- Air Force Environmental Engineering Laboratory, Tyndall AFB, FL

The above-named entities within DOD are interested in EPA's wastewater research strategy, and expressed interest in reviewing the draft document. In general, they look to EPA for much of their basic information in providing guidance to their "clients," e.g., the military operating offices and individual bases. Their goals are as follows:

- Bring all military installations in conformance with Federal, state, and local environmental regulations, both existing and proposed.
- Characterize and quantify wastewater emissions from military activities with emphasis on wastes unique to the military, e.g., shell casing cleaning, jet engine testing, etc.

- Conduct research into the analysis, monitoring, treatability, recycle/reuse, etc. of military wastewaters, again with emphasis on wastes unique to the military.
- Provide guidance to base personnel, design engineers, regulatory agencies, etc., in the implementation of cost-effective wastewater treatment and sludge management. Guidance is in the form of manuals, directives, plan review, etc.

In summary, the military has a limited wastewater research budget. They attempt to make maximum use of published EPA research information in the implementation of their wastewater planning. Their perceived research needs are as follows:

- Identification and quantification of toxic/hazardous constituents in military wastewaters. At present, except for the Aberdeen group, DOD has little information about the presence of priority pollutants in wastewaters.
- Treatability of military wastewaters to remove priority pollutants in the most cost-effective manner from both domestic and industrial sources. They are also interested in unit treatment processes, treatment systems, and land treatment alternatives. Work carried out under the purview of the Industrial Wastewater R&D Strategy would also be of interest here.
- Management of residuals, e.g., sludge from wastewater treatment.
- Development of inexpensive analysis and monitoring methods for critical constituents in military wastewaters. DOD hopes that EPA research will identify surrogate chemicals so that DOD will not be faced with monitoring a wide spectrum of organic and inorganic pollutants.
- Because most of its bases are located on the coast, the Navy is particularly interested in marine discharge of priority pollutants, regarding a need for control when the receiving water is not potable.
- Because most of their bases contain large land areas, the Army and Air Force are particularly interested in land treatment of wastes containing priority pollutants. Areas of major interest include the impact of landspreading, rapid infiltration or overland flow in mitigating potential adverse environmental effects.
- Wastewater recycle/reuse for both non-potable and potable purposes.

HOUSING AND URBAN DEVELOPMENT (HUD)

HUD is interested in EPA research which will ease the development of new housing through solution of wastewater management problems. HUD's perceived research needs are as follows:

- Small flows management with emphasis on rapid information transfer of new technology developments to the local level where builders and regulatory agencies operate. Specific areas include:
  - Design of on-site systems, e.g., septic tanks, individual home biological units, etc., including use of such units for clusters of dwelling units.
  - Management programs for maintenance of on-site systems, e.g., public septic tank maintenance districts, etc.
  - In-house water conservation and water reuse, tied into building code modifications and, where possible, energy conservation.
- Increased acceptance and reliability of alternate collection systems, e.g., pressure sewer and vacuum sewer systems.
- Elimination of inadequacies in POTW's which result in building moratoriums. HUD is interested in research which leads to increased capacity and reliability of existing POTW's, e.g., flow equalization, upstream retention, chemical treatment enhancement and improved O&M. HUD is also interested in means for speeding up new POTW construction through streamlining of the construction grant, permit, review, etc., process.

U.S. GEOLOGICAL SURVEY (USGS)

USGS's primary interest in EPA wastewater research is in tying together EPA and USGS activities pertinent to systematizing the interrelationships between stream flows, water quality and wastewater discharges. USGS perceives no need for EPA research per se to satisfy its own objectives, but sees itself as providing important input to EPA research efforts in such areas as:

- Development of wasteload allocations in receiving waters
- Eventual development of a surface water data management system which ties together all wastewater discharges (by location, quantity, and quality), receiving water identification by a nationally indexed system for each reach of river, stream, etc., surface water flow and

quality of each reach, and effect of present and proposed discharges upon each surface waste's reach

- A similar system for non-point source data management

Research of the character indicated above does not directly influence the nature of R&D discussed in this document. Rather, these research areas fall under the purview of the Water Quality Research Committee.

U.S. DEPARTMENT OF AGRICULTURE (USDA)

USDA is interested in research into wastewater and sludge land treatment as it may affect food crops and/or livestock which are affected presently or may be affected in the future by contact with the waste-amended soil. It perceives the following research needs in municipal wastewater:

- Long-term effects upon soil which receives municipal wastewater or sludges, in terms of suitability for various crops, productivity and physical and chemical changes. USDA is also interested in mitigating management practices.
- Uptake, by various edible crops, of toxics harmful to human health
- Bio-concentration of toxics in livestock which feed upon crops grown in soil amended with wastewater or sludge
- Potential health effects upon agricultural workers from bacteria, viruses, parasites, etc.
- Changes in irrigation and fertilization practices necessary when using wastewater or sludges vs. use of freshwater and commercial fertilizers

EPA has several cooperative efforts with USDA in non-point source control, e.g., USDA's controlled watersheds and small watersheds programs. In addition, EPA is conducting cooperative investigations with USDA in the pesticide area and in a study of metals in soils and food crops in the U.S. Finally, USDA is beginning an internal aquaculture program which will complement related EPA programs. USDA also cooperated with EPA and the U.S. Army Corps of Engineers in preparing and distributing the "Process Design Manual for Land Treatment of Municipal Wastewater."

U.S. FOOD AND DRUG ADMINISTRATION (FDA)

The EPA coordinates its research efforts in several areas with FDA, including shellfish pollution studies and studies of crop uptake of pollutants from wastewater or sludge-amended soils. FDA is also conducting similar uptake studies on lands treated with commercial fertilizers. Perceived research needs by FDA include:

- Continued investigation of plant uptake of wastewater and/or sludge contaminants
- Investigation of livestock bio-concentration of these contaminants (particularly in liver, kidney and other vital organs) when fed fodder grown in wastewater or sludge-amended soils
- Continued investigation of shellfish contamination from municipal wastewater

While not noted as a need by FDA, consideration might be given to transfer of information in the priority pollutant area. Many canned and preserved foods and beverages contain water added in processing. As EPA learns more about the prevalence, toxicity, etc., of these pollutants in water supplies, this information should be used by FDA. As in the case of the USDA, FDA research requirements are more properly the responsibility of the Water Quality Research Committee.

THE COUNCIL ON ENVIRONMENTAL QUALITY (CEQ)

In the past, CEQ has placed major emphasis on control of toxic pollutants, preservation of water resources and pollution control in balance with economic costs. The Council's interest in EPA's water pollution program has focused around the Construction Grants Program and, in particular, on the implementation of the Innovative and Alternative (I&A) Technology effort initiated by EPA. The Council has had a high level of interest in the construction grants program and in implementing the "Innovative and Alternative" technology sections of the Clean Water Act. However, the current reorganization of CEQ leaves doubt about its future activities.

DEPARTMENT OF INTERIOR/OFFICE OF WATER RESEARCH AND TECHNOLOGY (DOI/OWRT)

OWRT conducts a broad-based water resources research program focusing primarily on the following topics:

- Water Reuse. Emphasis here is on industrial reuse and irrigation using recycled wastewater. Potable reuse is not considered a major end use for renovated wastewater due to high costs and the potential risks to public health.
- Water Conservation. Potential for water conservation is large and several projects are under way to demonstrate its applicability.
- Water Problems of Urban Areas. While no organized stormwater control program has been established, several university research programs funded by OWRT are addressing the problem in specific locales.
- Saline Water Conversion Technology. Reverse osmosis, electrodialysis and other advanced processes are under development. Funds for five desalting demonstrations have been authorized (but not appropriated). OWRT also provides support for California's Water Factory 21.

OWRT is currently participating with both EPA and DOE in a project to clean up textile dyeing wastes for reuse, and also rents a mobile treatment unit to EPA for use at industrial sites. OWRT and EPA jointly sponsored a wastewater reuse seminar in the spring of 1979. In addition, ORD regularly assists OWRT in the annual review of grant applications submitted in the wastewater reuse area, thus facilitating technical interchanges between the two organizations and insuring that duplication of research efforts is avoided.

APPENDIX B

OFFICE OF RESEARCH AND DEVELOPMENT TECHNICAL INFORMATION OUTPUTS FOR THE MUNICIPAL WASTEWATER RESEARCH COMMITTEE

Research Committee		Product Type/Lab	Project Title/P.O.	Date
H	OWPO Bastian	Project Report HERL-Ci	Mechanism of Intestinal Cadmium Absorption in Rats # (Kowal)	2/81
H	OWPO Bastian	Journal Article HERL-Ci	Normal Levels of urinary Cadmium & Beta$_2$-Microglobulin in the U.S. # (Kowal)	3/81 d-81-092
H	OWPO Bastian	Journal Article HERL-Ci	Influence of pH and Electrolyte Composition on the Adsorption of Poliovirus by Soils and Minerals #(Akin)	7/81 J-81-252
H	OWPO Longest	Project Report HERL-Ci	Health Risks of Human Exposure to Wastewater # (Jakubowski - 210)	12/80 1-81-002
H	OWPO Bastian	Project Report HERL-Ci	Health Risks Associated with Wastewater Sprinkler Irrigation # (Pahren)	1/81
H	OWPO Bastian	Project Report HERL-Ci	Aerosols Generated by Liquid Sludge Application to Land # (Kowal -229)	3/81 1-81-028
H	OWPO Bastian	Journal Article HERL-Ci	Virus Removal During Groundwater Recharge: Effects of Infiltration Rate on Adsorption of Poliovirus to Soil # (Akin -207)	6/81 J-81-208
H	OWPO Thomas	Project Report HERL-Ci	Reovirus in Water Pollution Testing # (Akin)	6/81
H	OWPO Thomas	Project Report HERL-Ci	Viruses in Water and Reclaimed Wastewater # (Akin)	6/81
H	OWPO Bastian	Project Report HERL-Ci	Development of Improved Microbial Aerosol Measurement Methodology # (Jakubowski)	2/81
H	OWPO Bastian	Project Report HERL-Ci	Study of Microbial Aerosols Emitted from a Water Reclammation Plant # (Jakubowski)	4/81
H	OWPO Bastian	Project Report HERL-Ci	Assessment of Health Risks from Microorganisms in Sludge Applied to Land # (Kowal)	12/80
H	OWPO Bastian	Project Report HERL-Ci	Assessment of Cadmium Exposure and Toxicity Risk in an American Vegetarian Population # (Kowal)	9/81

Research Committee		Product Type/Lab	Project Title/P.O.	Date
H	OWPO Bastian	Project Report HERL-Ci	Evaluate Contaminant Uptake in Aquaculture Systems # (Kowal)	8/81
H	OWPO Bastian	Journal Article HERL-Ci	Health Effects Associated with Wastewater Treatment and Disposal # (Kowal)	6/81 J-81-175
H	OWPO Bastian	Project Report HERL-Ci	Survival of Ascaris Eggs in Sludge Applied to Soils # (Schaefer)	7/81
H	OWPO Bastian	Project Report HERL-Ci	Potential Health Effects from Viable Emissions and Toxins Associated with Wastewater Treatment Plants and Land Application Sites # (H. Pahren - 236)	8/80
H	OWPO Longest	Project Report HERL-Ci	Health Effects of Sewage Aerosols. Additional Serological Surveys and Search for Legionella Pneumophila in Sewage # (W. Jakubowski - 292)	12/80 1-81-032
H	OWPO Bastian	Project Report HERL-Ci	Determination of Health Risks Associated with Processing and Land Application of Sludge # (Pahren)	12/80
H	OWPO Bastian	Unpublished Report HERL-Ci	Comparison of Extraction Methods and Storage Conditions Enumerating Viruses in Municipal Sewage Sludge #(Pahren)	11/80 0-80-049
H	OWPO Bastian	Project Report HERL-Ci	Model of Virus Treatability in Soils During Land Application of Wastewater # (Akin)	2/81
H	OWPO Bastian	Research Report HERL-Ci	Appraisal of Health Aspects of Land Applicationof Wastewater # (Kowal)	2/81
H	OWPO Bastian	Project Report HERL-Ci	Sewage Sludge Viral and Pathogenic Agents in Soil-Plant-Animal Systems # (H. Pahren - 289)	2/81 1-81-026
H	OWPO Bastian	Project Report HERL-Ci	Virus Soil Interaction # (Akin)	7/81
H	OWPO Longest	Tech Conf & Proc. HERL-Ci	Symposium on Disease Risks of Exposure to Wastewater and Wastewater Aerosols # (Pahren/Jakubowski - 183)	10/80

Research Committee		Product Type/Lab	Project Title/P.O.	Date
H	OWPO Longest	Tech Transfer Report HERL-Ci	Evaluation of the Potential Microbiological Exposure from Wastewater Aerosols from Spray Irrigation #(Pahren)	1/81
H	OWPO Bastian	Project Report HERL-Ci	Development of Methodology for Determining Risk Assessment when Sludge is Applied to Land # (Kowal -219)	2/81
H	OWPO Bastian	Project Report HERL-Ci	Sewage Sludge Pathogen Transport Model Project # (Kowal - 224)	11/80 1-81-049a/b
H	OWPO Bastian	Speech HERL-Ci	The Occurrence of Human Enteroviruses in a Long Island Groundwater Aquifier Recharged with Tertiary Wastewater Effluents # (Akin -207)	6/81 d-81-188
H	OWPO	Project Report MERL-Ci	Identify and Quantify Factors Affecting POTW System, Subsystem and Process Reliability Including Impact of Toxics # (J. Bender)	2/81
H	OWPO	Project Report MERL-Ci	Improved Clarifier Performance and Reliability Through Demonstrated Improvement in Hydraulic Efficiency # (J. Bender)	10/80
H	OWPO	Project Report MERL-Ci	Improved Performance of Rectangular Secondary Clarifiers Through Improvements in Hydraulic Efficiency #(J.Bender)	10/80
H	OWPO A. Hais	Design Manual MERL-Ci	Manual of Septic Tank Practice # (R. Bowker)	8/80 1-80-012
H	OWPO A. Hais	Project Report MERL-Ci	Investigation of Settling Rates for Air- and Oxygen-Activated Sludges # (R. Brenner)	11/80
H	OWPO A. Hais	Project Report MERL-Ci	Evaluation of Single-Stage, Covered Reactor Oxygen Activated Sludge System # (R. Brenner)	11/80
H	OWPO A. Hais	Project Report MERL-Ci	Feasibility Study of Open Tank Oxygen-Activated Sludge Wastewater Treatment # (R. Brenner - D-1/15)	6/31 2-81-095
H	OWPO A. Hais	Problem Oriented Report MERL-Ci	Development of Design Criteria and Preparation of Comprehensive "Grass Roots" Cost Est. for Biological Processes # (R. Brenner)	4/81

Research Committee	Product Type/Lab	Project Title/P.O.	Date
H OWPO A. Hais	Project Report MERL-Ci	Emerging Technology Assessment Reports - Vertical Tube Reactor # (R. Bowker)	1/81
H OWPO A. Hais	Project Report MERL-Ci	Emerging Technology Assessment Reports - Fine Bubble Diffusers # (R. Bowker)	1/81
H OWPO A. Hais	Project Report MERL-Ci	Emerging Technology Assessment Reports - Anaerobic Processes # (R. Bowker)	1/81
H OWPO A. Hais	Project Report MERL-Ci	Emerging Technology Assessment Reports - Solar Applications # (R. Bowker)	1/81
H OWPO A. Hais	Project Report MERL-Ci	Emerging Technology Assessment Reports - Deep Shaft # (R. Bowker)	1/81
H OWPO A. Hais	Project Report MERL-Ci	Emerging Technology Assessment Reports - Overland Flow # (R. Bowker)	1/81
H OWPO A. Hais	Project Report MERL-Ci	Emerging Technology Assessment Reports - Anaerobic Digestion of Combined Wastes # (R. Bowker)	1/81
H OWPO A. Hais	Project Report MERL-Ci	Emerging Technology Assessment Reports - Aquaculture # (R. Bowker)	1/81
H OWPO A. Hais	Project Report MERL-Ci	Emerging Technology Assessment Reports - Wetlands Treatment # (R. Bowker)	1/81
H OWPO/A. Hais Reg 7/Harrington	Problem Oriented Rpt MERL-Ci	Evaluation of Activated Bio-Filtration System # (R. Brenner)	2/81
H OWPO A. Hais	Problem-Oriented Report MERL-Ci	Survey, Documentation and Analysis of Existing European and United States Plant Operating and Performance Data on Fine-Bubble Aeration # (R. Brenner)	12/80
H OWPO A. Hais	Problem Oriented Report MERL-Ci	Determination of Oxygen Transfer Capabilities Under Standardized Test Conditions of New Generation Submerged Air Aeration Equipment # (R. Brenner/Kugelman)	5/81

Research Committee	Product Type/Lab	Project Title/P.O.	Date
H OWPO	Journal Article MERL-Ci	Assessment of Control Strategies for Selected Unit Operations by Evaluation of Field Data & Computer Simulation # (M. Cummins)	12/80
H OWPO	Project Report MERL-Ci	Soil Temperature and Sewage Sludge Effects on Plant and Soil Properties # (G. Dotson)-	4/81 2-81-069
H OWPS/Athayde OWPO/Longest	Project Report MERL-Ci	Nationwide Assessment of Receiving Water Impacts from Urban Stormwater Pollution # (J. English)	1/81 2-81-025
H OWPO	Project Summary MERL-Ci	Demonstrate Within Vessel Composting of Sewage Sludge # (A. Eralp)	9/80
H OWPO/Walker	Project Report MERL-Ci	Analysis and Assessment of Incinerated Sludge # (A. Eralp)	8/81
H OWPO	Project Report MERL-Ci	Lime Stripper for Toxic Metals Removal Prior to Biological Treatment # (S. Hannah)	5/81
H OWPO	Journal Article MERL-Ci	Lime Stripper for Toxic Metals Removal Prior to Biological Treatment # (S. Hannah)	5/81
H OWPO A. Hais	Project Report MERL-Ci	Vacuum Sewer Technology/Septage Mgmt # (J. Kreissl)	9/81
H OWPO A. Hais	Project Report MERL-Ci	Pressure Sewer Technology # (J. Kreissl)	12/80
H OWPO K. Dearth	Project Report MERL-Ci	Technical Assistance for Upgrading Unacceptable Facility Plans for Three Small Communities # (J. Kreissl)	12/80
H OWPO	Project Report MERL-Ci	Parallel Evaluation of Air- and Oxygen-Activated Sludge # (I. Kugelman - 731)	10/80
H OWPO A. Hais	Design Manual MERL-Ci	Process Design Manual for Wastewater Stabilization Ponds # (E. Barth)	9/81
H OWPO/Hais	Project Report MERL-Ci	Feasibility Evaluation of Intermittent Slow-Sand Filter Trench System for Treating Raw Wastewater # (R. Lewis)	1/81

Research Committee		Product Type/Lab	Project Title/P.O.	Date
H	OWPO Hurd	User's Guide MERL-Ci	Community-Wide Management of Onsite Wastewater Systems Study, Including Analysis of Existing Systems and Development of Guidelines for Optimum System - (J. Kreissl)	7/81
H	OWPO	Project Report MERL-Ci	Evaluate Private Sector Expertise for Conducting CCP Approach Improving Performance of POTWs # (F. Evans)	11/80
H	OWPO	Project Report MERL-Ci	Survey and Performance Analysis of POTWs Operated by Contractural Agreement # (J. Bender - C10)	5/81
H	OWPO	Journal Article MERL-Ci	High Level Ozone Disinfection of Municipal Wastewater Effluents # (E. Opatken - 823)	3/81 2-81-040
H	OWPO/Walker	Project Report MERL-Ci	Field Study of Factors Determining Metals Uptake by Crops Grown on Sludge Treated Soils # (J. Ryan)	2/81
H	OWPO/Bastian	Project Report MERL-Ci	Demonstration of Autothermal Thermophilic Aerobic Digestion with Air # (B. Salotto)	11/80
H	OWPO/Bastian	Journal Article MERL-Ci	Demonstration of Autothermal Thermophilic Aerobic Digestion with Air # (B. Salotto)	10/80
H	OWPO	Project Report MERL-Ci	Evaluation and Optimization of Anaerobic Digestion of Municipal Sludge # (B. Salotto)	5/81
H	OWPO	Project Report MERL-Ci	Investigation of Effectiveness of Lime Treatment on Viability of Parasites in Sludge Combined with Survey of Parasite Viability in Raw & Treated Sludges # (G. Stern)	6/81
H	OWPO	Project Report MERL-Ci	Determine Effect of Grazing Sludge Treated Pastures, & Direct Sludge Ingestion by Cattle # (G. Stern)	8/81
H	OWPO/Bastian	Project Report MERL-Ci	Helminth and Heavy Metals Transmission from Anaerobically Digested Sewage Sludge # (G. Stern)	1/81 2-81-024
H	OWPO/ Longest	Project Report (4) MERL-Ci	Demonstrate Periodic Flushing for First Flush Abatement as Low-Cost CSO Pollution Control # (R.Turkeltaub)	5/81

Research Committee		Product Type/Lab	Project Title/P.O.	Date
H	OWPO A. Hais	Problem-Oriented Report MERL-Ci	Reduction of Toxicity Emission Rates from Municipal Treatment Plants by Optimization of Chlorination Process # (A. Venosa)	5/81
H	OWPO A. Hais	Project Report MERL-Ci	Ultraviolet Disinfection of Filtered and Unfiltered Secondary Effluent # (A. Venosa)	1/81
H	OWPO A. Hais	Research Report MERL-Ci	Ultraviolet Disinfection of Secondary Sewage #(A.Venosa)	1/81
H	Region 3	Project Report MERL-Ci	Effect of Sulfur Dioxide Dechlorination on Receiving Stream # (A. Venosa)	12/80
H	OWPO A. Hais	Journal Articles MERL-Ci	Develop Cost Effective Ozone Contactor for Optimum Utilization & Disinfection # (A. Venosa)	4/81
H	OWPO	Project Report MERL-Ci	Plant-Scale Study of Combined Incineration of Sewage Sludge with Coal & Solid Waste # (H. Wall)	12/80
H	OWPO	Project Report MERL-Ci	Study of Modifications Required to Convert Multiple Hearth Incinerator to Pyrolytic Operation # (H. Wall)	12/80
H	OWPO	Project Report MERL-Ci	Determination of Economics of Solvent Drying of Sludge & Evaluation of Fertilizer Value of Dried Product # (H. Wall)	3/81
H	OWPO	Project Report MERL-Ci	Application of Packed Bed Gas Producers to Production of Combustible Gases from Municipal Wastewater Sludges # (H. Wall)	10/80
H	OWPO/Walker	Research Report MERL-Ci	Determination of Incinerator Discharges by RTP Revised Sampling & Analysis Procedure # (H. Wall)	10/80
H	OWPO	Research Report MERL-Ci	Volatile Organics in Aeration Gases at Municipal Treatment Plants # (H. Warner)	3/81
H	OWPO/Hais	Project Report MERL-Ci	Rotating Disk Evaporation # (R. Bowker)	1/81

Research Committee	Product Type/Lab	Project Title/P.O.	Date
H Region 1	Project Report MERL-Ci	Demonstration of Composting of Septage # (R. Bowker)	1/81
H	Project Report MERL-Ci	Interim Treatment Plant Demonstration # (J. Kreissl)	1/81
H	Project Report MERL-Ci	Fate of Semivolatile Priority Pollutants in a Wastewater Treatment Plant # (R. Williams - 827)	4/81* 2-81-056
H OWPO/Longest Athayde/NURP	Users Manual MERL-Ci	Develop and Apply a New Cost Effective Methodology for Determining the magnitude and Characteristics of Urban Runoff Loads from Areas with Combined Sewer Systems by Statistical Analysis # (D. Ammon - 111168)	3/81
H OWPO/Longest Athayde/NURP	Users Manual MERL-Ci	Develop Users Manual for WWF Sampling/Monitor Based on Critical Sensitivities and Analyze the Sensitivity... # (D. Ammon - 209156)	9/81
H OWPO	Project Report MERL-Ci	Joint Dry/Wet Weather Treatment of Municipal Wastewater at Clatskanie, Oregon # (D. Ammon - 310152)	3/81 2-81-061
H OWPO	Project Report MERL-Ci	Integrated Control of Combined Sewer Regulators Using Weather Radar # (D. Ammon - 908)	3/81
H OWPO/Hais	Project Report MERL-Ci	Evaluation of Cost/Benefit for Various Phosphorus Residuals in Municipal Effluents # (E. Barth)	11/80
H OWPO/Hais	Project Report MERL-Ci	2001 Study # (R. Bowker - 33)	1/81
H OWPO/Dearth	Project Report MERL-Ci	Upgrading Facility Plans # (R. Bowker - 38)	1/81
H Region 1	Project Report MERL-Ci	Septage Digestion # (J. Kreissl - 03)	7/81
H OWPO/Hais	Project Report MERL-Ci	Assessment of Composting Toilets and Graywater Systems # (S. Hathaway - 30)	5/81

Research Committee		Product Type/Lab	Project Title/P.O.	Date
H	OWPO/Hais	Project Report MERL-Ci	Hydrogen Peroxide Study # (J. Hidman - 42)	10/81
H	OWPO/Hais	Project Report MERL-Ci	Evaluation of Small Diameter Gravity Sewers # (J. Heidman - 44)	10/81
H	OWPO	Project Report MERL-Ci	Monitoring and Evaluating of 5.5 mgd Cedar Creek Wastewater Reclammation-Recharge Facilities # (J. English-19)	9/81
H	OWPO	Project Report MERL-Ci	Evaluation of the Characteristics and Treatability of Urban Runoff Residuals # (J. English - 421230)	9/81
H	OWPO/Athayde NURP/Reg 5/Elson	Project Report MERL-Ci	Evaluation of BMP in Urban Stormwater in Connection with EPA's NURP # (J. English - 425000)	8/81
H	OWPO/Hais	Project Report MERL-Ci	Soil System Design and Restoration # (J. Kreissl - 16)	5/81
H	OWPO/Hais	Journal Article MERL-Ci	I/A Program - Eight Articles for Publication in Various Journals promoting I/A program # (G. Lubin)	6/81
H	OWPO/Hais	User Group Pub MERL-Ci	Progress in EPA's Technology Program # (R. Bowker)	9/80
H	OWPO/Hais	Speech MERL-Ci	Impact of Innovative & Alternative Technology in the United States in the 80's # (J. Smith - 905)	11/80 d-81-100
H	OWPO	Project Report MERL-Ci	Model Protocol for Comprehensive Evaluation of POTW Performance and Operation # (F. Evans - D8)	
H		Speech MERL-Ci	Urban Stormwater Management and Pollution Abatement Alternatives # (R. Traver - 876)	1/81
H		Speech MERL-Ci	Stormwater/Combined Sewage Pollution Abatement Alternatives # (R. Traver - 377)	1/81
H		Published Paper MERL-Ci	Urban Stormwater Management and Pollution Abatement Alternatives # (R. Traver - 876)	12/80

Research Committee	Product Type/Lab	Project Title/P.O.	Date
H	Published Paper MERL-Ci	Stormwater/Combined Sewage Pollution Abatement Alternatives # (R. Traver - 877)	12/80
H OPTS/Conroy	Project Report MERL-Ci	Toxic Chemicals in Household Wastewater, Septic Tank Effluents and Residuals and Soils Absorbing the Latter # (J. Kreissl - 34)	6/81
H OWPO & OWPS	Project Report MERL-Ci	Storm and Combined Sewer Storage Treatmentfor Theory Compared to Computer Simulation # (R. Field)	7/81 2-81-125
H OWPO & OWPS Athayde/Longest/ Nurp	Users Guide MERL-Ci	Update Comprehensive Planning Methods for Urban Stormwater Management Incorporating Recent SOTA Improvements and Provide Maintenance/Dissemination Service #(D.Ammon)	6/81
H OWPO/Potter	Project Report MERL-Ci	Optimization of Operation of a System of Small Treatment Plants # (J. Bender - D3)	3/81
H OWPO/Potter	Project Report MERL-Ci	Economic Analysis of Operational and Management Modes for Groups of Small Wastewater Treatment Plants # (R. Eilers - D5)	7/81
H OWPO/Walker	Project Report MERL-Ci	Evaluation of Fixation Incineration Sludge # (A. Eralp - C24)	6/81
H OWPO/Walker	User Group (ACS) MERL-Ci	Planning of a Symposium on Thermal Conversion of Solid Wastes, Residues, and Energy Crops # (A. Eralp - B22)	8/81
H OWPO & OWPS Athayde/Nurp	User's Guide MERL-Ci	Demonstrate/Disseminate the SWIRL Concentrator Principle # (R. Field)	6/81
H OWPO/OWPS OWRS/O'Farrell	Journal Article MERL-Ci	Collection & Analysis of Stormwater/CSO and Sediment Samples for Priority Pollutants # (R. Turkeltaub)	3/81
H OWPO, EGD	Project Report MERL-Ci	Survey Treatment Plants which have Suitable Data on Toxic Metals Content of Influent, Effluent, Sludge & Information on Industrial Contributions of Metals & Organics # (S. Hannah)	1/81

	Research Committee	Product Type/Lab	Project Title/P.O.	Date
H	OWPO, EGD	Project Report MERL-Ci	National Survey of Treatment Plants for Selected Toxic Metals and Organics # (S. Hannah)	3/81
H	OWPS/Athayde OWPO/M. Tiemens	Technical Conf & Proc MERL-Ci	Conference on Urban Stormwater and CSO Impact on Receiving Water Bodies # (R. Turkeltaub)	11/80 9-80-056
H	OWPS/WPD D. Athayde	Project Report MERL-Ci	Evaluation of Secondary Impacts of Urban Runoff Pollution Control # (D. Weisman)	7/81
H	OWPO/Hais	Project Report MERL-Ci	O&M Practices and Problems of Land Treatment Processes # (J. Bender)	7/81
H	OWPO/Potter	User Group Pubs MERL-Ci	Impact of Plant Recycle Streams and Return Flows on POTWs Failure to Meet NPDES Requirements # (J. McCarthy)	4/81
H	OWPO/Hais	User Group Pubs MERL-Ci	Identification and Correction of Typical Design Deficiencies in Municipal Wastewater Treatment Facilities # (J. McCarthy)	3/81
H	OWPO/Hais	Project Report MERL-Ci	Demonstrate Improved Performance at Selected Biological Treatment Plants # (F. Evans)	9/80
H	R. Christensen	Project Report MERL-Ci	Demonstration for Control & Treatment of Combined Sewer Overflows in City of Saginaw # (R. Traver)	1/81
H	OWPO	Speech MERL-Ci	Behavior of Priority Pollutants in Conventional Water Pollution Control Systems # (I. Kugelman)	12/80
H	OWPO	Unpublished Report MERL-Ci	Evaluation of Ozonation System for Wastewater Disinfection # (E. Opatken)	1/81
H	OWP/Bastian	Project Report MERL-Ci	Production of Non-Food-Chain Crops with Sewage Sludge # (G. Stern - 709)	1/81 2-80-199
H	OWPS/OWPO OWE/OPTS	Project Report MERL-Ci	Reduction of Pollutants in Municipal Sewage Sludge to Levels Consistent with Land Disposal # (S. Hannah-AE-05)	1/81

Research Committee	Product Type/Lab	Project Title/P.O.	Date
H OWPS/OWPO	Project Report MERL-Ci	Literature Study of Biodegradability of Chemical Substance in Water # (S. Hannah - AE-09)	3/81
H OWP/Bastian	Project Report MERL-Ci	Determine Beneficial and Detrimental Effects of Long-Term Use of Digested Sewage Sludge on Crop Land # (G. Dotson - CO 5)	8/81
H OWP/Bastian	Project Report MERL-Ci	Demonstrate feasibility of Renovating Impoverished Land with Sewage Sludge # (G. Dotson - C 15)	5/81
H OWP/Bastian	Project Report MERL-Ci	Determine Safe Beneficial Loading Rates for Various Sludge-Soil-Crop Combinations Following Many Years of Sludge Use # (G. Dotson - C28)	9/81
H OPS/Niehus	Project Report MERL-Ci	Estimating and Ranking Socioeconomic Effects of Alternative Water Quality Management Strategies # (F. Evans - C 13)	6/81 5-81-001
H OWPO/Longest	Users Guide MERL-Ci	Document Real Time Data from CSO in an Urban Lake and Develop a Control Methodology for CSO Control Based on Impact # (R. Field - 205166)	1/81
H OWPO/Longest Athayde/NURP	Project Report MERL-Ci	Support Engineering Services for Evaluation of the SWIRL Regulator/Concentrator Facility, City of Lancaster, Pennsylvania # (R. Field - 317000)	8/81
H OPS/Niehus	Project Report MERL-Ci	Improved Methods of Defining Ambient Water Quality Standards # (J. Heidman - C 14)	6/81
H OWPO	Project Report MERL-Ci	Reactivation of Granular Carbon in an Infrared Furnace # (I. Kugelman - BE22)	6/81
H OWPO	Project Report MERL-Ci	Removal of Toxic Compounds Including Priority Pollutants from Secondary Effluent by Activated Carbon # (I. Kugelman - BE24)	6/81

Research Committee		Product Type/Lab	Project Title/P.O.	Date
H	Region 8/ Herrington	Design Info Series MERL-Ci	Design Guidelines - Impact of Peak Flows on Conventional Wastewater Treatment Processes # (J. Bender-B6)	3/81
H	Region 8/ Herrington	Design Info Series MERL-Ci	Document Operation and Performance of Rotating Biological Contactors (RBC) for Municipal Waste Treatment and Issue Interim RBC Design Guidelines # (J. Bender - B7)	3/81
H	OWPO	Project Report MERL-Ci	Areawide Stormwater Pollution Analysis with the Macroscopic Planning (MAC) Model. Vol I. Documentation and Applications; Vol II. User's Manual # (D. Ammon -207299)	3/81
H	OWPO/Hais	Project Report MERL-Ci	Develop and Update a Computer Cost and Performance Data Base for Biological Wastewater Treatment Processes # (J. Bender - B9)	1/81
H	OWPO/Hais	Project Report MERL-Ci	Evaluation and Documentation of Mechanical Reliability of Conventional Plant Components # (J. Bender - C2)	3/81
H	OWPO/Hais	Design Info Series MERL-Ci	Development of Methodology and Guidelines for Systems Reliability Analysis # (J. Bender - C7)	6/81
H	OWPO/Hais Reg 7/Harrington	Problem Oriented Rpt MERL-Ci	Development of a Proposed Consensus Standard for Testing and Evaluating Oxygen Transfer Equipment # (R. Brenner - D-2/13)	3/81
H	OWPO/Potter	Project Report MERL-Ci	Evaluate and Demonstrate Effectiveness of Central Management of O&M Programs (Phase I) # (M. Cummins - D4)	1/81
H	OWPO/Hais	Project Report MERL-Ci	Characterization of Nonvolatile Organics in Wastewater Effluents Disinfected with chlorine, Ozone, and Ultra-Violet Light # (C. Mashni - A/15)	1/81
H	OWPO/Walker	User Group (USDA) MERL-Ci	Develop a Feasible Method fo Composting Raw Sewage Sludge with Other Carbonaceous Materials and Demonstrate the Engineering and Economic Feasibility (USDA has published) # (J. Ryan - C10)	12/80

Research Committee		Product Type/Lab	Project Title/P.O.	Date
H	OWPO/Walker	Project Report MERL-Ci	Develop Techniques for Separation and Characterization of the Organic Fraction of Metals in Sludge Amended Soils # (J. Ryan - C20)	4/81
H	OWPO/Walker	Project Report MERL-Ci	Develop Techniques for Separation and Characterization of the Inorganic Fraction of Metals in Sludge and Sludge Amended Soils # (J. Ryan - C21)	4/81
H	OWPO/Walker	Project Report MERL-Ci	The Effect of pH and Phosphorous on Uptake and Phytotoxicity of Zn, Cu, Ni, and Cd to Plants Grown in Soil # (J. Ryan - C49)	6/81
H	OWPO	Project Report MERL-Ci	Engineering Assessment of Hot-Acid Treatment of Municipal Sludge for Heavy Metals Removal # (B. Salotto - A 55)	4/81 2-81-075
H	OWPO/Bastian	Project Report MERL-Ci	Pilot Scale Anaerobic Filter Treatment of Heat-Treatment Liquor # (B. Salotto - A 33)	6/81 2-81-114
H	OWPO/Bastian	Journal Article MERL-Ci	Pilot Scale Anaerobic Filter Treatment of Heat-Treatment Liquor # (B. Salotto - A 33)	4/81
H	OSW	Project Report MERL-Ci	Density Levels of Pathogenic Organisms in Municipal Wastewater Sludge # (G. Stern - 8 -A/54)	6/81
H	Reg 5 Christensen	Project Report MERL-Ci	Best Management Practices Implementation for CSO Control # (R. Traver - 408159)	1/81
H	OWPO/Longest	Research Report MERL-Ci	Assessment of Sewer Sealant for Infiltration/Inflow Control # (R. Traver - 414174)	1/81
H	OWPO/Longest Athayde/NURP	Project Report MERL-Ci	Evaluate Urban Runoff Mutagenicity # (R. Turkeltaub - 110211)	5/81
H	OWPO/Hais	Research Report MERL-Ci	Demonstrate/Evaluate the "Insituform" Approach for Sewer Infiltration/Inflow Control # (R. Turkeltaub - 416170)	5/81

Research Committee		Product Type/Lab	Project Title/P.O.	Date
H	OWPO	Project Report MERL-Ci	Demonstrate/Evaluate/Compare "Instituform" with Other Sewer Rehabilitation Techniques # (R. Turkeltaub - 420170)	5/81
H	OWPO/Hais	Project Report MERL-Ci	Indigenous Virus Inactivation at Selected EPA Ozone and Ultraviolet Light Projects # (A. Venosa - A/17)	12/80 2-81-088*
H	OWPO/Bastian	Project Report MERL-Ci	Assessment of Contemporary Sludge Management Technology... # (R. Villiers - A/54)	9/81
H	Reg 5/Christensen Reg 2/Moriarty	Project Report MERL-Ci	Combined Sewer Overflow Abatement Program, Rochester NY (Vol I, Abatement Analysis) # (D. Weisman - 405131)	1/81
H	OWPO/Athayde/ NURP	Project Report MERL-Ci	Disposal of Sludge from CSO Treatment # (D. Weisman - 409209)	1/81
H	OWPO/Longest Athayde/NURP	Project Report MERL-Ci	Water Quality and Biological Effects of Urban Runoff on Coyote Creek # (D. Weisman - 410223)	4/81
H	OWPO/Athayde NURP	Project Report MERL-Ci	Treatment of Stormewater by a Marsh/Flood Basin # (D. Weisman - 412226)	5/81
H		Project Report MERL-Ci	Economic/Financial Analysis of Urban Water Quality Management Problems (M 817) # (R. Field -)	11/80
H		Project Report MERL-Ci	Engineering and Economic Assessment of Autoheated Thermophilic Aerobic Digestion with Air Aeration # (R. Villiers - 68-03-2803)	1/81
H		Project Report MERL-Ci	Control Strategies for Automation of Conventional Biological Treatment Plants and Associated Solids Handling System # (I. Kugelman - E1)	6/81
H		Speech MERL-Ci	Control Strategies for Automation of Conventional Biological Treatment Plants and Associated Solids Handling System # (I. Kugelman - E1)	6/81

Research Committee	Product Type/Lab	Project Title/P.O.	Date
H	Project Report MERL-Ci	Automatic Control Systems for a P/C Biological Wastewater Treatment Plant # (I. Kugelman - E5)	3/81
H	Project Report MERL-Ci	Investigation of Phase Isolation Wherein Lagoons Effluents are Temporarily Isolated in Holding Ponds for 10-20 Days... # (R. Lewis - D-2/06)	10/80
H	ORD Brief MERL-Ci	Demonstrate and Develop Guidelines for Sediment and Erosion Control Techniques for Highway Construction Sites in Southeast Piedmont Soils # (R. Field)	3/81
H	Users Guide MERL-Ci	Effects of Sewage Sludge on the Cadmium and Zinc Content of Crops (This was done by the Council for Agri. Sci. & Technol.) # (J. Ryan -)	11/80 8-81-003
H	Project Report MERL-Ci	Heavy Metal Bioavailability in Sludge-Amended Soils # (J. Ryan - 804614)	5/81
H	Speech MERL-Ci	Feasibility Study of Establishing Instrument Certification Laboratory for Instruments to be Used in POTW's # (W. Schuk - E 7)	6/81
H	Project Report MERL-Ci	Numerical Simulation of Aerated Sludge Composting # (R. Smith - 788)	11/80 2-80-191
H	Journal Article MERL-Ci	Numerical Simulation of Aerated Sludge Composting # (R. Smith - 788)	11/80 3-80-168
H	Project Report MERL-Ci	Evaluate the Effectiveness of Treating CSO in a Very Deep Detention Basin Having Aerobic and Anaerobic Treatment with Chlorine/Chlorine Dioxide Disinfection # (R. Traver - 202176)	1/81
H	Project Report MERL-Ci	Develop a Decision Optimization Methodology which will be Applicable to In-Plant Residuals Management to Minimize Cost and Energy Consumption for Sludge Treatment Alternatives # (L. Rossman - B1A)	9/80

Research Committee	Product Type/Lab	Project Title/P.O.	Date
H	Speech MERL-Ci	Behavior of Selected Organic Compounds in Wastewater Collection and Treatment Systems # (A. Petrasek, Jr.)	8/80 S-80-014
H	User's Guide MERL-Ci	Methodology for Evaluating the Impact and Abatement of Combined Sewer Overflows; A Case Study of Onondago Lake, New York # (R. Field)	8/80 8-80-048
H	Project Report MERL-Ci	First National Symposium/Workshop on Rotating Biological Contractor Technology (Volume I) # (E. Opatken)	9-80-046a
H	Project Report MERL-Ci	First National Symposium/Workshop on Rotating Biological Contractor Technology (Volume II) # (E. Opatken)	9-80-046b
H	Project Report MERL-Ci	Economic/Financial Analysis of Urban Water Quality Management Problems # (D. Ammon)	2-80-187
H	Proceedings MERL-Ci	Proceedings for the 7th United States/Japan Conference on Sewage Treatment Technology # (J. Convery)	9-80-047
H	Problem Oriented Rpt MERL-Ci	Proceedings for the 7th United States/Japan Conference on Sewage Treatment Technology # (J. Convery)	3/81* 8-81-006
H	Journal Article/Book MERL-Ci	Toxics in Municipal and Industrial Wastewater # (D. Bishop)	10/80* J-80-116
H	Project Report MERL-Ci	GC/MS Methodology for Priority Organics in Municipal Wastewater Treatment # (D. Bishop)	2-80-196
H	Speech MERL-Ci	Urban Stormwater Management and Pollution Abatement Alternatives # (R. Traver - 876)	d-81-004
H	Speech MERL-Ci	Stormwater/Combined Sewage Pollution Abatement Alternatives # (R. Traver - 877)	d-81-007
H ORD/Ehreth	Project Report MERL-Ci	A Feasibility Analysis # (G. Dotson)	4/81
H	User's Guide MERL-Ci	Specifications and Testing Protocol for Automatic On-Line Measuring Instruments for Use in POTW's # (W.Schuk)	10/80

Research Committee	Product Type/Lab	Project Title/P.O.	Date
H EGD/OWE	Project Report MERL-Ci	Biodegradation and Carbon Adsorption of Carcinogenic and Hazardous Organic Compounds # (R. Dobbs - 810)	1/81 2-81-032
H OWPO/Bastian	Project Report MERL-Ci	—Engineering Assessment of Vermi Composting Municipal Wastewater Sludges # (R. Villiers - 733)	3/81
H OWPO/Bastian	Project Report MERL-Ci	—Lime Stabilization and Ultimate Disposal of Municipal Wastewater Sludges # (R. Villiers - 932)	4/81 2-81-076
H OWPO	Project Report MERL-Ci	Full Scale Demonstration of Waste Sludge Incinerator Fuel Reduction # (H. Wall - B 20)	3/81
H OWPO	Project Report MERL-Ci	Technical, Environmental and Economic Co-Disposal System, Research Evaluation # (H. Wall - B 13)	6/81
H	Project Report MERL-Ci	A Case History for Implementing Land Spreading of Lagooned Sewage Sludge on Farmlands # (G. Stern - C 52)	9/81
H	Project Report MERL-Ci	A Technical and Economic Analysis of Dedicated Land Disposal # (G. Stern - C 61)	9/81
H	Project Report MERL-Ci	An Economic Analyses for Reclaiming Strip Mine Land Using Sewage Sludge as Compared to Commercial Methods # (G. Stern - C 62)	9/81
H	Journal Article MERL-Ci	Toxic Pollutant Classification and Removal by Counter-current Centrifugation # (C. Fronk-Leist)	12/81
H	Project Report MERL-Ci	Trace Organic Removal from Activated Carbon Treated Municipal Wastewater Effluents # (S. Hannah - 18)	1/81
H	Project Report MERL-Ci	EXEC/OP Reference Manual, Version 1.2 # (L. Rossman)	2-80-182
H	Project Report MERL-Ci	Proceedings: Wastewater Alternatives for Small Communities # (S. Hathaway - 855)	9-80-062
H	Speech MERL-Ci	Toxics in Municipal and Industrial Wastewater # (D. Bishop)	11/80

Research Committee	Product Type/Lab	Project Title/P.O.	Date
H	Project Report MERL-Ci	Integrated Control of Combined Sewer Regulations Using Weather Radar # (D. Ammon - 908)	3/81* 2-81-041
H	Project Report MERL-Ci	Field Evaluation of a SWIRL Degritter at Tamworth, New South Wales, Australia # (H. Wilder - 314000)	3/81 2-81-063
H	Project Report RSKERL-Ada	Nitrogen & Phosphorus Reactions in OF of Wastewater # (B. Bledsoe)	5/81
H	Project Report RSKERL-Ada	Infiltration Land Treatment of Stabilization Pond Effluent # (C. Enfield)	12/80
H	Project Report RSKERL-Ada	Advanced Biological Teatment of Municipal Wastewater Through Aquaculture # (W. Duffer)	4/81
H	Project Report RSKERL-Ada	Determine Kinetics of Phosphorus Mineralization in Soils Under Oxidizing Conditions # (C. Enfield)	7/81
H	Project Report RSKERL-Ada	Reclammation of Heavy Metal Contaminated Soils # (W. Dufer)	4/81
H	Project Report RSKERL-Ada	Soil & Crop Management Systems for Treatment, Utilization & Disposal of Municipal Wastewaters & Sludges # (L. Leach)	4/81
H	Project Report RSKERL-Ada	Soil Filtration of Sewage Effluent of a Rural Area # (L. Leach)	12/80
H	Journal Article RSKERL-Ada	Methods for Approximating Transport of Organic Pollutants to Groundwater (submitted for publication) # (C. Enfield)	12/80
H	Seminar/Report RSKERL-Ada	Overland Flow Seminar (to be conducted through EPA/TT) # (C. Harlin)	3/81
H	Workshop/Report RSKERL-Ada	Conference/Workshop on Selection & Management of Vegetation for Land Application Systems to Treat Municipal Wastewater in North Central U.S. # (C. Harlin)	5/81

Research Committee	Product Type/Lab	Project Title/P.O.	Date
H	Project Report RSKERL-Ada	Rationale for Rapid Infiltration Design (in summary of long-term Rapid Infiltration Studies) # (C. Enfield)	9/80
H	Project Report RSKERL-Ada	Field Testing of Overland Flow for Maximum Nutrient Removal Management # (B. Bledsoe)	5/81
H	Project Report RSKERL-Ada	Evaluation of Four High Rate Infiltration Systems # (L. Leach)	6/80
H	Project Report RSKERL-Ada	South Carolina Overland Flow Project # (B. Bledsoe)	6/81
H	Project Report RSKERL-Ada	Effects of travel Time on Treatment Performance # Overland Flow - (B. Bledsoe)	8/81
H	Journal Article RSKERL-Ada	Overland Flow Treatment of Lagoon Effluent # (B. Bledsoe)	10/81
H	Project Report RSKERL-Ada	An Evaluation of Filter Feeding Fishes for Removing Excessive Nutrients from Wastewater # (W. Duffer)	9/81
H	Project Report RSKERL-Ada	Wastewater Treatment with Plants in Nutrient Film # (W. Duffer)	9/81
H	Project Report RSKERL-Ada	Design Criteria for Wetland Wastewater Treatment # (W. Duffer)	10/81
H	Journal Article RSKERL-Ada	Optimization of Nitrogen Control in Rapid Infiltration Land Treatment Systems # (L. Leach)	9/81
H	Project Report RSKERL-Ada	Treatment of Primary Effluent by Rapid Infiltration # (L. Leach - 8101)	2/81
H	Journal Article RSKERL-Ada	Four-Step Numerical Scheme for Finite Element Analysis of a Saturated-Unsaturated Soil System # (C. Enfield)	12/80
H	Journal Article RSKERL-Ada	Transport of Phosphorus Ions Through Soils Under Two Dimensional Transient Flow Conditions # (C. Enfield)	5/81

Research Committee	Product Type/Lab	Project Title/P.O.	Date
H	Journal Article RSKERL-Ada	Mathematical Prediction of Toxicant Transport Through Soil # (C. Enfield)	2/81
H	Symposium/Article RSKERL-Ada	Comparison of One and Two Dimensional Models for Organic Transport Through Agricultural Soils # (C. Enfield)	4/81
H	Project Report/PS EMSL-LV	Impact of Metals on aquatic Life: Final Report on Results from 14 Sites # (T. Miller)	9/81

APPENDIX C

MUNICIPAL WASTEWATER RESEARCH COMMITTEE
AND SUBCOMMITTEE MEMBERS

Research Committee Members

James Basilico, Co-Chairman	Office of Research and Development
David Kleffman	"
Doug Lipka	"
Dick Thomas, Co-Chairman	Office of Water and Waste Management
Denis Athayde	"
Jim Bachmaier	"
Rod Frederick	"
Alan Hais	"
Margie Pitts	"
Jeffrey Miller	Office of Enforcement
Steve Natch	Office of Toxic Substances
John Gustafson	Office of the Administrator
John Convery	MERL-Cincinnati
Curtis Harlan	RSKERL - Ada, OK
Daniel O'Brien	Region I
Richard Caspe	Region II
Steve Poloncsik	Region V

Residuals, Toxics and Urban Runoff Subcommittee

David Kleffman	Office of Research and Development
Bala Krishnan	"
Rod Frederick, Chairman	Office of Water and Waste Management
Dennis Athayde	"
Bob Bastian	"
Jim Spatarella	"
Steve Nacht	Office of Toxic Substances
Jim Bachmaier	Office of Solid Waste
Carl Ferrentino	"
Carl Brunner	MERL-Cincinnati
Robert Bunch	"
Herb Pahren	HERL-Cincinnati
William Dunlap	RSKERL-Ada, OK
Steve Poloncsik	Region V

Innovative Technology and Process Development Subcommittee

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Bob Bastian	Office of Water and Waste Management
Keith Dearth	"
Pete Eagan	"
Lam Lim	"
Dick Thomas	"
Jim Wheeler	"
Dave Rogers	Office of Enforcement
John Thillman	Office of Planning and Evaluation
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Ed Barth	"
Jim Kreissl	"
John Smith	"
Curtis Harlan	RSKERL-Ada, OK
Steve Poloncsik	Region V

APPENDIX D

HEADQUARTERS AND LABORATORY STAFF CONTACTS FOR MUNICIPAL WASTEWATER RESEARCH PROGRAM OUTPUTS

HEADQUARTERS

Office of Environmental Engineering & Technology

Waste Management Division, Acting Director	Jim Basilico	202-426-4567
Land Treatment, Small Wastewater Flows and Process Development	Ray Thacker	-4567
Municipal Sludge, Plant Operations and Design and Toxic Pollutants Control	Bala Krishnan	-4567
Innovative/Alternative Technology and Urban Runoff	Tom Pheiffer	-4567
Health Effects	Tom Gleason	-4567

Office of Health Research

Control Technology Health Effects	Dave Kleffman	202-426-2317

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Anaerobic Digestion	Vince Salotto	-7667
Composting	Atal Eralp	-7663
Dewatering	Bud Villiers	-7664
Incineration and Pyrolysis	Howard Wall	-7659
Land Spreading	Ken Dotson	-7661
Stabilization	Jerry Stern	-7654

Toxic Pollutants Control	Jesse Cohen	-7671
Carbon Adsorption	Dick Dobbs	-7649
Metals Control	Sid Hannah	-7651
Physical/Chemical Treatment	Jesse Cohen	-7671
New Process Development	Bob Bunch	-7655
New Biological Processes	Dick Brenner	-7657
Disinfection	Al Venosa	-7668
Specific Pollutants	Ed Barth	-7641
Reuse/Conservation	John English	-7613
Plant Operations and Design	John Smith	-7611
Urban Runoff (Edison, NJ)	Richard Field	201-321-6674
Small Wastewater Flows	Jim Kreissl	513-684-7614
Clearinghouse	"	"
Innovative & Alternative Technology	John Smith	-7611
Clearinghouse	Gary Lubin	-7630
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Instrumentation & Automation	Irv Kugelman	-2621
Testing & Evaluation Facility	Al Petrasek	-2628
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Land Application of Wastewater	Curtis Harlin	405-332-8800 (CML) 743-2212 (FTS)
Overland Flow	"	" "
Rapid Infiltration	"	" "
Slow Rate Irrigation	"	" "
Aquaculture Treatment Systems	Bill Duffer	-2243 (FTS)

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